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## AND PATTERN-MAKER.

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## Forthcoming Events.

MARCH 7.

*British Foundrymen's Association (Lancashire Branch).*—Paper by Mr. G. Hailstone.

MARCH 13.

*British Foundrymen's Association (London Branch).*—"Organisation," by F. Blackwell.

MARCH 14.

*British Foundrymen's Association (Birmingham Branch).*—Paper by R. Buchanan, F.R.S.A.

MARCH 28.

*British Foundrymen's Association (Scottish Branch).*—Annual general meeting.

*British Foundrymen's Association (Halifax Branch).*—"Comparisons of the Mechanical, Chemical, and Microscopical Tests of some Iron and Steel," by E. W. Smith, B.A. B.Sc.

*British Foundrymen's Association (Birmingham Branch).*—"A Day in the Foundry," by J. G. Robinson.

## NOTES AND COMMENTS.

### Brass Castings in Permanent Moulds.

In the course of a recent discussion on brass founding the question of casting brass in permanent moulds was raised; but the process did not appear to be familiar to British brass founders. The question has the very important aspect that the process is being successfully conducted abroad in competition with British-made castings; and a consideration of some of the factors involved may not be out of place. Probably the reason why the practice is not well known here is that it is practically a branch of the die-casting process familiar as being for some years employed in connection with the white alloys of comparatively low melting points; and since die-casting is carried out with expensive apparatus specially designed by the users for their own use as makers of die-castings, the trade is in a few hands only.

The difficulties involved in the work have so far largely restricted the process to the metals or alloys with low melting points, and only recently can the application of die-casting to the brasses proper be said to have become a commercial fact. Considerable difficulty is experienced in getting sound castings from permanent moulds, and many founders who have made trials and failed have discarded the process as worthless. But the fact that such moulds have proved a commercial success for certain classes of repetition iron work in itself would suggest that a similar field in brass work is open for them. The chief points to be considered in casting iron by this process are (1) the nature of the metal used for the mould, a low-silicon, high-graphitic-carbon foundry iron being deemed most suitable, (2) the temperature of the mould, (3) the design of the mould, and (4) the dressing of the mould. It is important to remember that the moulds should not act as chills, and to this end they are raised to a considerable temperature before the metal is poured. They are preferably designed with joints which accommodate the inevitable expansions during solidification and the final contraction; and to prevent the molten metal from biting into the surface a wash of some hydrocarbon such as a paraffin is often applied. In addition to this the moulds are opened and the castings thrown out while at a bright cherry-red heat, and before the mould has greatly cooled another casting is poured. This means that the detrimental effects of the repeated expansion and contracton through heating and cooling are largely avoided. Of course, those effects are ultimately felt and result in deterioration of the surface of the mould after a time. For cored work either suitable dry-sand cores or iron cores are used, according to the nature of the work. We have seen motor-car cylinders cast with sand-cores in permanent moulds, and the resulting castings have been excellent, of fine grey fracture when broken for inspection, and chilling being entirely absent.

Since the difficulties encountered in the casting of grey iron in permanent moulds have been proved surmountable, there is little reason to think that brass cannot be similarly cast, particularly as aluminium

has also been satisfactorily subjected to the process. The use of permanent moulds for casting rolling brass is probably well-known to most foundrymen. The moulds are made of a soft grey iron. A coating of lard oil is applied prior to casting to prevent the metal acting on the iron. The mould, as with iron, is warmed before pouring in the metal. The burning of the oil also prevents oxidation of the stream of metal as it is being poured. We recall that an American apparatus was patented recently for casting high-melting-point metals under pressure. The mould was made of cast iron or steel and arranged so that it could be tilted. The metal was placed in a ladle coated with graphite to prevent loss of heat, and the whole then inserted in a chamber at the top of the mould. At the bottom a pipe was connected and this was attached to a vacuum pump to produce a vacuum in the mould. At the top of the mould another pipe was used for forcing compressed air into it. The mould was then tilted, and at the same time the compressed-air valve was opened so that the metal, as it left the ladle was forced into the mould. By the use of the combined vacuum and pressure, it was claimed the metal was made dense and sound. The trouble experienced with casting brass into permanent moulds can undoubtedly be overcome by experiment and due consideration to the design and venting of the mould, the temperature of both mould and metal, the cleanliness and method of pouring the metal, and the time of discharging the casting from the mould. Naturally, the inflexibility of the permanent mould places some considerable limitations on the application of the process, while further limitations are imposed by the cost of designing and making the moulds, repetition work being the only field. But within that field we may look for great advances in the near future.

**Foundry and Drawing Office.**

On another page appears some correspondence resulting from remarks on this subject made in our issue of January last. The discussion turns essentially on the desirability of producing perspective drawings for the use of the moulder. We discountenanced the suggestion as being impracticable and continue to do so, since any conceivable advantage is far outweighed by the cost. In our last issue a correspondent objected to our statement that perspective drawing was not mechanical drawing, and submitted instead that since " solid geometrical representation is worked out correctly with mathematical instruments," it can be mechanical drawing. This is the first time we have found the term " mechanical drawing " interpreted as covering all drawings produced by mechanical means or mathematical instruments; and we do not think the interpretation will stand examination. Linear perspective may quite correctly be classed as geometric drawing, but the term " mechanical drawings " has a distinct significance that is well understood and must not be extended indefinitely. We have seen various " cubist " paintings which might have been produced by means of set-squares and a protractor, but we doubt whether they would be accepted as mechanical drawings. A moment's consideration of the work of a mechanic, whether engineering or otherwise, who employs drawings for constructional particulars (as distinct from general appearances) will reveal the one paramount fact that he deals essentially with planes, surface or sectional, and not optical views. In this lies the essence of the whole question. It is conceivable that to one who cannot read a mechanical drawing, a perspective sketch is far simpler; but if he has to use it as a guide in his operations, it will be required to give all the details presented by the mechanical drawing, though how the details of any complicated casting can be intelligibly presented without the usual mechanical drawings we do not know. Nor would a perspective sketch of, say, a matchbox, however accurately produced by means of mathematical instruments, convince us that the same principle could be intelligibly employed for presenting such work as, say, a locomotive piston valve cylinder. Perspective sketches would serve a most useful purpose in illustrating a description of the making of the patterns, but few patternmakers would care to make the pattern from those sketches alone.

Another contention put forward by the same correspondent was that since the moulder was not responsible for sizes, form, etc., (this being the patternmaker's business), there was no advantage in his ability to read a machine drawing. As a matter of fact, if we are supposed to accept the moulders duties as comprising solely the unintelligent covering of a pattern with a moulding material and the ultimate extraction of the said pattern, we must then entirely agree with our correspondent as to the value of drawings and the ability to read them—they would serve no purpose. But why, in such circumstances, bother about supplying picture views of the casting that will ultimately result. Such sketches might be edifying to the moulder, but he would probably prefer a copy of the daily paper, which would be far less trouble to procure. The truth is, our correspondent has overlooked the fact that while drawings are frequently found most useful in the hands of the moulder, it is not the mere rammer of sand in boxes who requires them. Apart from a considerable range of loam work, in which properly-dimensioned mechanical drawings are a necessity for the preparation of tackle and the setting out of the work by the moulder, there are many classes of sand work where the details given on a mechanical drawing greatly assist in the construction of the mould, the arranging of the runners, risers, etc., and the placing of the cores. A moulder with sufficient intelligence to handle intricate work can usually readily learn to read *correct* mechanical drawings, and his requirements in this direction can be supplied at the cost of a few pence at the most for a blue print.

This raises a technical point also, which our correspondent appears to have overlooked—probably as the result of the capacity to prepare presentable perspective sketches of fairly simple parts *without* the use of mathematical instruments; that is, that although linear perspective, to be accurate, is worked out according to geometric rules and with mathematical instruments, to do this work necessitates preparing the mechanical-drawing views first, in order to determine the various vanishing points and distances for the perspective views. This means that so far from perspective sketches (presuming they are to be accurately prepared) taking the place of mechanical drawings, they are entirely *additional*, with the whole cost (not a small item if done correctly) chargeable against the foundry department. What would the management say to this? Finally, we submit that while experience may show that pictures are more readily understood than mechanical drawings, and though they serve an admirable purpose as illustrations for descriptive and instructional purposes, that is no reason why we should place a premium on the ignorance of the moulder, in the matter of reading drawings, by supplying him with a facility which is supplied to no other department, and is further both expensive and unnecessary. It is far more to the point to train the men to a desirable standard, than to foster their incapacity; but in this matter probably our correspondent has too poor an opinion of the possibilities inherent in the moulder.

# The Early History of Ironfounding.*

By Henry B. Wheatley, D.C.L., F.S.A.

PART I.

The history of the ancient ironworks of the country is one of considerable interest, and worthy of a fuller treatment than has as yet been accorded to it. Most of the forges were situated in the neighbourhood of large forests where a sufficient supply of charcoal was to be obtained, but the continual toll of the furnaces caused in course of time a serious depletion of the woods of the country, thus raising feelings of great public anxiety, and producing a large number of Acts of Parliament, which, however, were not very successful in staying the evil.

### Sussex.

For several centuries the most important of the ironworks were situated in the South of England, and the thickly-wooded county of Sussex was the chief source of the native iron supply until the end of the 17th century. Mr. M. A. Lower, who has compiled a list of fifty-four parishes in the county where ironworks were established, produces evidence which supports the view that after the Roman occupation, ironworks were established in various parts of the kingdom. There are many extensive fields of scoriæ in Sussex, which have been used for the repair of the roads. From the Roman period until after the Norman conquest there is little or no reference to the trade, and Mr. Lower says the earliest actual record of the iron trade in Sussex is contained in the murage grant made by Henry III. to the town of Lewes. This grant, which is dated 1266, empowers the inhabitants to raise tolls for the repair of the town walls after the famous battle of that year. Every cart laden with iron from the neighbouring weald for sale paid one penny toll, and every horse-load of iron half that amount. In 1290 a payment was made for the ironwork of the monument of Henry III. in Westminster to Master Henry of Lewes. Previously the name of this artificer appears in connection with ironwork for the king's chamber. In the thirteenth year of Edward II. Peter de Walsham, sheriff of Surrey and Sussex, by a precept from the king's exchequer, made a provision of horseshoes and nails of different sorts for the expedition against the Scots. The number furnished was 3,000 horseshoes and 29,000 nails, and the expense of their purchase, from various places within the sheriff's jurisdiction and their delivery in London by the hands of John de Norton, was £14 13s. 10d.

Iron manufactured on the Sussex coast was conveyed to London by sea. The Ashburnham Ironworks were of considerable extent, and were continued as late as the year 1825 Gloucester Furnace, the largest iron manufactory in Sussex, was principally in the parish of Lamberhurst, and partly in that of Wadhurst. It took its name from the Duke of Gloucester—son of Princess Anne, afterwards Queen—who, with his mother, visited it from Tunbridge Wells on its completion. The original railings round St. Paul's were wrought at Lamberhurst, and cost £11,202 0s. 6d. They weighed, with the seven gates, 200 tons. It is believed that many of the other ironworks of Sussex largely helped in the production of these railings.

Iron ordnance is said to have been made in Sussex in the 15th century, and a mortar long preserved at Eridge Green, in the parish of Frant, was believed to be the first made in England. The first cannon known to be cast in England was manufactured at Buxted, Sussex, by Ralph Hoge or Hogge in 1543. His family resided at a place near Buxted Church, called from the rebus, or "name device" over the front door, the 'Hog-house." Hogge was assisted by Peter Baude, a Frenchman. The manufacture of heavy ordnance gave a great impulse to the iron trade, and about 1572 much ordnance was exported, in consequence of the Lord Admiral having granted a licence for that purpose to Sir Thomas Leighton; but the merchants of London petitioned Queen Elizabeth to withdraw the licence, and this was done by proclamation in September, 1572, strictly restraining all transport of iron and brass ordnance. In spite of this, Sussex cannons were surreptitiously exported for some years longer. Complaints were made that Spain armed her ships with cast-iron cannon, and in spite of prohibition the export continued. Such dastardly conduct on the part of Englishmen in the struggle for life against Philip II. must have filled the hearts of patriots with disgust.

The cannon foundry at Worth employed, in the middle of the 16th century, 33 men, out of which number eight were gun-founders and ten labourers. There were also one hammerman, one filler, five colyers, and three miners.

Thomas Fuller, in referring to Sussex in his "Worthies," wrote: "It is almost incredible how many great guns are made of the iron in this county. Count Gondomar well knew their goodness, when of King James he so often begged the boon to transport them."

The Gloucester Furnace, Lamberhurst, was ruined by reason of irregular proceedings, in which it was found that cannon cast for the British Navy in the 18th century were conveyed by smugglers to the coast and there shipped to French privateers. In consequence of the discovery of these criminal proceedings the Government contracts were withdrawn, and the works naturally declined. Mr. Lower obtained this information from Mr. W. Courthope, Rouge Croix, afterwards Somerset Herald, one of whose ancestors was ironfounder to Charles II. The counties of Kent, Surrey, and Hants. have all been the home of ironworks, but the history of this industry there has not been so fully investigated as in the case of Sussex.

### Kent.

At Hawkhurst, on the Sussex border, William Penn, the Quaker, started and worked the first furnace there. Archbishop Parker was much concerned at the idea of the establishment of ironworks at Westwell, and when writing to Queen Elizabeth in 1570 he said: "Sir Richard Sackville intends, as I was credibly informed, in [Longbeech Wood] to erect up certain iron mills, which plague, if it shall come into the country, I fear will breed much grudge and desolation."

Two centuries before the establishment of the Westwell Ironworks there is evidence of the existence of several forges in Kent. Mr. M. S. Giuseppi, F.S.A., read before the Society of Antiquaries, on December 5, 1912, a most valuable Paper on "Some Fourteenth Century Accounts of Ironworks at Tudeley, Kent," in which he is able "to follow the history of what may have been a typical wealden ironworks in the 14th

* Abstract of Paper read before the Royal Society of Arts, and printed in the "Journals" of the Society.

century over a period of nearly 50 years, and to gain some idea of the extent of its business, of the cost of production of the iron, and in a vague way of the process in use and of the implements which made up the stock-in-trade."

One works, at Newefrith-juxta-Bournemelne (Bournemill is now a farm to the south-west of Somerhill Park), must have been considerably more important than the Tudeley Works, as it was leased for a year at five marks, whilst the Tudeley lease was only leased for one mark (13s. 4d.). Two other ironworks were leased to one Thomas Harry. The output of the forge averaged more than 200 blooms a year, the market price being 1s. 8d. a bloom. After the Black Death of 1349, the price was more than doubled. There is no indication of the probable size or weights of the bloom, but Mr. Giuseppi says that in the Byrkeknott Works the bloom is definitely stated to have contained 15 stones, each stone consisting of 13 lbs.

### Hampshire.

The earliest mention of ironworks in this county is in Domesday Book, where there is an entry under Stratfield (now Strathfieldsaye), of a *ferraria* at this place which paid 2s. 3d. Ironworks were established in Hammerbottom near Haslemere, and Bramshot, at an early period, and heaps of iron slag still exist in the woods adjoining Hammerbottom.

The most important ironworks in this county were those at Sowley, near Lymington. Sowley Pond Ironworks were of some importance. On the southern coast of Hants, particularly on the coast of Beaulieu Manor, ironstone was formerly gathered in some quantity. It was generally rolled up by the surf, and it is said that to gather this in people left the harvest fields. It was conveyed to the ironworks at Sowley.

Several place-names in the New Forest, such as Irons Hill Wood, near Lyndhurst, and Ironmill Hill, near Fawley, prove the existence of ironworks in these places.

### Surrey.

Although the names of several places in Surrey, such as Abinger Hammer, Hammerbridge on the Mole above Leigh, Hammer Vale and Farm near Haslemere, indicate the existence of forges, there is no actual mention of ironworks before 1553, when Christopher Darrell established works at Ewood in Newdigate.

Three places in Surrey have the distinction of being excepted from one of the old Acts for the preservation of timber in 1558-9. Another Act was required 22 years after this, as the destruction of the woods proceeded at so rapid a rate as to be alarming. The wealds of Surrey, Sussex and Kent were specially excepted, and also the particular ironworks at Newdigate are specially named. These Acts were found to be of little avail, and a more stringent one became necessary. This was 27 Eliz. c. 19 (1584-5): "An Act for the preservation of Tymber in the Wildes of the Counties of Sussex, Surrey and Kent, and for the amendment of Highe Waies decaied by carriages to and fro Iron mills there." It was enacted that "no new Ironmills, Furnace, Finery or Bloomery shall be erected in these counties, nor bodies of Timber trees of one foot square used in such furnaces," under a penalty of £300 for each mill, and 40s. for each tree. It is added, "Tops and offals of trees may be employed as fuel for Ironworks in certain places," and "Occupiers of Ironworks shall for every ton of Iron, carry and lay on the roads certain quantities of cinders, gravel, etc., according to direction of Justices of Peace."

John Norden, in his "Surveyor's Dialogue" (1607), expresses the opinion that there was still abundance of wood, but he adds, "He that knoweth the Welds of Sussex, Surrey and Kent shal find such an alteration within lesse than 30 years, as may well strike a fear lest few yeeres more as pestilent as the former, will leave few good trees standing in those welds. Such a heate issueth out of the many forges and furnaces as hath devoured many famous woods within the welds."

### Iron Imports and Exports.

Many enactments respecting the importation and exportation of iron manufactures are to be found in the "Statutes of the Realm," and it may be interesting to refer shortly to these before proceeding further. Scrivenor says that during the period from the Conquest to the death of King John in 1216, iron and steel were imported into England from Germany and other countries as the domestic supply was insufficient. The Normans contributed much to the development of the English iron manufacture.

One of the earliest enactments for the prevention of the exportation of English iron is 28 Edw. III. c. 5 (1351):—

"It is accorded and established that Iron made in England, and Iron brought into England and there sold, shall not be carried out of the said Realm of England, upon pain of forfeiting the Double to the King; and the justices assigned [shall have power] to enquire of Labourers, and the other Justices whom the King will thereto assign, shall have power to enquire of them that sell Iron at too dear a price, and to punish them after the quantity of the Trespass."*

This Act was followed a century later by another to prevent importation of manufactured iron articles from abroad (3 Edw. IV. c. 4, 1463):—

"Certain Merchandises shall not be brought into this Realm ready wrought." The merchandises recited are saddles or any harnesses pertaining to saddles, spurs, bosses of bridles, aundirons, gridirons, any manner of locks, hammers, pinsons, fire tongs, dripping pans, harness of girdles of iron, etc.†

Another Act to the same effect is 1 Ric. III. c. 12 (1483-4), in which are mentioned seisors, andirons, gredirons, lokkes, keys, hynges, knives, hangers, tailloursbires.‡

In the year 1636 Charles I. granted a commission to Sir David Cuningham, Christopher Lewknor and others for the better preservation of the timber in the woods:—

"Whereas several offences have been heretofore and still are done and committed by maisters, owners, and occupiers of ironworks, forges, furnaces, or hammers for melting and making of iron, by felling, cutting, and converting of timber trees and woods into coals for the melting and making of the said iron, etc., and by felling the said trees, and underwood at unseasonable parts of year, whereby the bark thereof hath been lost."

There were several suits touching these offences pending in the Court of Star Chamber, and the duty imposed on the Commissioners was "to treat and compound with" the offenders and to levy for the King's use such sums as they should see fit. The Commission was dated August 19, 1636. On October 14 following an office "to be for ever continued," was erected for the better management of the iron trade, and the King appointed John Cupper and Grimbald Pauncefoote, gentlemen, surveyors of all ironworks, and of all woods to be used and employed thereat, and for the surveying and marking of iron with divers stamps or marks distinguishing the several kinds." On July 20, 1637, by an Order in Council, these regulations were put in force, and very stringent methods

* "Statutes of the Realm," 1o10 Vol. I., p. 345.
† *Ibid.*, Vol. II., p. 397.
‡ *Ibid.*, p. 495.

were adopted for the rectification of the evils complained of. A proclamation was issued in this same year to this effect:—"The King, by proclamation, ordered the pigs and bars of iron made in England to be marked by his surveyors of the ironworks, to prevent the sale of bad iron, and that iron was not to be exported without the King's licence under pain of forfeiture," etc. These surveyors were also empowered to enter any woods that "were felled, cut, or coarded, to be converted into coal for making of iron, whereby it might appear of what condition those woods were that should be employed that way, and that they be not cut down contrary to law."*

At the Restoration it was enacted that iron goods might be freely exported (12 Car. II. c. 4, s. 10, 1660):—

"It shall and may be lawful for any person or persons immediately from and after the passing of this Act to transport, ship, and carry out of this Kingdome or out of any port thereof by way of merchandize any of these commodities, goods, and merchandices following, that is to say, Iron Armor, Bandeliers, Bridle-bitts, Halbert-heades, and Straps, Holsters, Muskets, Carbines, Fowling-pieces, pistels, pike-heads, sword or rapier blades, sadles, snaffles, stirrups, etc."†

In 1719 a Bill was brought into Parliament for regulating the laws concerning the importation of naval stores from the British-American plantations, and to this it was proposed to add that none of the plantations should manufacture iron wares of any kind out of any sows, pigs, or bars whatsoever under certain penalties. The House of Lords wished to add another clause, that no forge going by water or other work whatsoever should be erected in any of the plantations for making sows, pigs, or cast iron into bar or rod iron. The colonists were so disgusted at these prohibitions that they desired the Bill to be entirely dropped, and it appears to have gone no further at this time, but the matter was brought up again in 1750. The chief opposers of the manufacture of iron in the American plantations were the proprietors of the ironworks at home.

26 Geo. II. c. 29, 1750:—"An Act to encourage the importation of pig and bar iron from his Majesty's colonies in America, and to prevent the erection of any mill or other engine for slitting or rolling of iron, or any plateing forge to work with a tilt hammer, or any furnace for making steel in any of the said colonies."‡

We learn from Anderson§ that in 1785 the high price and scarcity of fuel and the high price of labour in this country induced certain English proprietors of ironworks to transfer their capital to Russia, where they erected works. This untoward state of affairs caused the passing of the following Act (25 Geo. III. c. 67, 1785):—

"An Act to prohibit the exportation to foreign parts of tools and utensils made use of in the iron and steel manufactures of this kingdom, and to prevent the seducing of artificers employed in those manufactures to go into parts beyond the seas."‖

### Manner of Working Charcoal Furnaces.

Mr. Giuseppi, describing the process of reducing the wrought iron from the ore in the primitive Catalan forge in use in Kent in the 14th century, says that the bellows were worked by hand or by the feet, as there is no indication at Tudeley of the use of water-power by means of a mill-wheel, which afterwards became so marked a feature of the wealden works. Mr. Lower, in his Paper on the "Ironworks of Sussex," writes:—"We owe many of our finest sheets of water to the iron manufacture. In other circumstances the meadows which were converted into ponds and pools have again been drained and restored to their former use, or appropriated as hop-gardens and osier-beds. The sites of many of the hammers are now (1849) occupied by corn-mills. In choosing a site for the works, our iron-masters, of course, sought out spots which were at once contiguous to the beds of ore and to some convenient water-power. The places chosen for artificial ponds were generally the vales through which streams and rivulets flowed. Across these were thrown great dams of earth, usually known as pond-bays, with a convenient outlet of masonry for supply of water, by means of which the wheel connected with the machinery of the hammer or the furnace was set in motion."

Murray's "Handbook of Sussex" contains a description of the Ashburnham furnace, communicated by Mr. Bartlett, of Maidstone: "The bed of the furnace from which the iron was drawn to be cast into pigs was made of large blocks of stone taken from some of the rocks at Hastings, which were about 4 ft. square inside; two bellows, each about 12 ft. long, were worked by an overshot water-wheel. The iron ore was brought from pits some few miles distant. The fuel (charcoal) was made principally from oak trees on the estate. The blasting of this furnace was carried on at intervals of about three years, and continued to blast for about two or three months each time till the stock of material was used up."

Swank says that the first furnaces built in the Forest of Dean were 15 ft. high and 6 ft. wide at the boshes. The furnaces at work in the Forest in 1677 were blown with bellows 20 ft. long, driven by a great wheel turned by water.

John Ray, the naturalist, wrote "The account of the whole process of the ironwork," which is appended to his "Collection of English Words." He obtained the information from one of the chief iron-masters of Sussex, "my honoured friend Water Burrell, of Cuckfield, Esq., deceased."

### The Manner of Working the Iron at the Forge or Hammer.

"In every forge or hammer there are two fires at least; the one they call the *finery*, the other the *chafery*. At the finery, by the working of the hammer, they bring it in blooms and anconies, thus:—The sow they at first roll into the fire, and melt off a piece of about three-fourths of a hundredweight, which, so soon as it is broken off, is called a loop. This loop they take out with their shingling tongs, and beat it with iron sledges upon an iron place near the fire, that so it may not fall in pieces, but be in a capacity to be carried under the hammer. Under which they, then removing it, and drawing a little water, beat it with the hammer very gently, which forces cinder and dross out of the matter; afterwards, by degrees, drawing more water they beat it thicker and stronger, till they bring it to a bloom, which is a four-square mass of about 2 ft. long. This operation they call shingling the loop. This done, they immediately return it to the finery again, and after two or three heats and workings, they bring it to an *ancony*, the figure whereof is, in the middle, a bar about 3 ft. long, of that shape they intend the whole bar to be made of it; at both ends a square pipe left rough to be wrought at the chafery. *Note.*—At the finery three load of the biggest coals go to make one tun of iron. At the chafery they only draw out the two ends suitable to what was drawn out at the finery in the middle and so finish the bar. *Note.*—(1). One load of the smaller coals will draw out one tun of iron at the chafery. (2) They expect

* Rymer's "Foedera," XX. 161.
† "Statutes of the Realm," 1819, Vol. V., p. 183
‡ "Statutes at Large," 1769, Vol. VII., p. 261.
§ "Annals of Commerce," Vol. IV., p. 95.
‖ "Statutes at Large,' 1786, Vol. XIV., p. 705.

that one man and a boy at the finery should make two tuns of iron in a week; two men at the chafery should take up, *i.e.*, make or work, five or six tun in a week. . . .

As early as the beginning of the 15th century blast furnaces were introduced into England from the Continent. Prior to the introduction of blast furnaces, all iron that was made in England was produced in Catalan forges or high bloomeries directly from the ore, and was, therefore, when finished, wrought or bar iron. The two materials used in the manufacture of iron consisted of the ore and the charcoal, and there were general calculations as to the relative amount of each—that is, how much iron should be produced by the expenditure of so much charcoal. Mr. Giuseppi made some calculation on this point, from which it works out at an average of 15½ dozen of coals to the 100 blooms. The *duodena*, or dozen on the baker's principle, was reckoned at fourteen summagia or sumpter loads. The ore and the forests were generally near together, but it will be seen later on that in Scotland the ore was often carried some distance to the woods, as it was easier to carry the ore to the forest than the wood to the ore.

Among the Battle Abbey Deeds purchased *en masse* by the late Sir Thomas Phillipps, of Middle Hill, is a document called "Westable's Book of Pannyngrydge (1546)." It is the account book of some iron-master, and exhibits his expenditure in carrying on an extensive trade during the year indicated. Among the items are payments made to the woodcutters for "coards" of wood at 3d. per coard. (A cord has been described as a pile of wood 8 ft. long by 4 ft. high and 4 ft. broad, or more definitely as a measure of cut wood usually 128 cubic feet.) The "collears," or charcoal-burners, were paid in wood and money for coals at the rate of 22d. per load. There are also charges for the carriage of coals out of Pannyngrydge, Oliver's Wood and Asyldey at 4d. and 6d. a load, and for the "moyne [iron mine or ore] digged out of Pannyngrydge." The price of digging was 7d. per load, and many payments to "Black Jack" and others occur in these accounts. Several sums are paid to Warnet, the founder, and to Anthony the "filler." One entry shows the locality of the works: "For carrying of lodes of sand from Pannyngridge unto my forge at Robertsbridge at xvj*d.* the lode."

There are further sums paid Mr. Chancellor for the farm of his woods at Pannygrydge and to the parson of Penherst for the farm of the phurner [furnace] pond there and for tithe. Also for the hewing and felling of timber, "for drawing of timbre to the sawstage," etc. The accounts close with an entry of v*s.* 6*d.* paid "for a wrytte and a warrant for Jackson, the carpenter."*

A few of the names relating to the charcoal iron industry seem to need some explanation.

Bloomery, or Blomary, is "the first forge in an ironworks, through which the metal passes after being melted from the ore, and in which it is made into blooms." In Act 27 Eliz. c. 19, we find "any maner of yron mille, furnace, hammer, fiarie, forge, or blomary," enumerated. *Bloma ferri* occurs in Domesday Book.

Hammer, as Abinger hammer, hammer pond, furnace pond, furnace wood, furnace field, forge pond, forge field, and stream furnace, are favourite names in iron districts.

Cinder is the technical name for iron slag, and such names as Cinderford, Cindergill, Cinderhill, Cinder banks, Cinder field, are also to be found more or less over the country.

* Thorpe's "Descriptive Catalogue of the Muniments of Battle Abbey," 1835, quoted in "Sussex Archæological Collections," 1849, Vol. II., p. 185.

## British Foundrymen's Association

### Newcastle-upon-Tyne Branch.

The annual dinner of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association was held in the Collingwood Restaurant, Newcastle-upon-Tyne, on January 31. Mr. R. Wallis (Branch-President) was in the chair, supported by Mr. J. Weir, Vice-Chairman, and others.

Mr. James Smith proposed the toast of "Our Association," and Mr. S. A. Gimson (President of the Association) in responding, remarked that their Association was entirely educational—an Association to help on the foundry trade. He thought this country had allowed America and Germany to outstrip them in technical education, but he saw no reason why they should not have one of the best technical educational systems in the world. He would like all the branches of their Association to give prominence to the question of the best way of training apprentices. He thought a certain slackness had crept in with regard to the training of apprentices, and he wanted this remedied.

"The Visitors" was proposed by the Vice-President (Mr. J. Weir), and in response, Prof. H. Louis remarked that at such gatherings as that they came into contact with men who were doing the practical every-day work of the metallurgist. There were many reasons why it was difficult for the practical man to follow the scientific side of problems, and that to a certain extent was left to the University men, but it was only by coming into contact with the practical foundryman that the University man was able to probe and find out the particular points to which they should direct their attention. At Armstrong College they were doing all they could for the industry.

Mr. R. Wallis replied to "Our President," proposed by Mr. J. W. Paulin. During the course of the evening, Mr. H. A. J. Rang, the Hon. Secretary of the local Branch of the Association, was presented with a silver salver and a cigar case in recognition of his efforts on behalf of the Branch.

### Re-Lining a Steel Pump.

It is well-known among steel founders that sulphur and phosphorus prevent the successful casting of linings in the other castings or the welding on of pieces to broken or defective castings by the ordinary burning-on process. To successfully accomplish this work it is necessary to employ exceedingly low-phosphorus and low-sulphur steel. A pump casing cast from open-hearth steel and which was worn out within a few months in handling water which contained a large amount of sharp sand, was recently lined with a hard-steel lining, which was cast into the parts and welded throughout to the old material. The work was done by the Columbia Steel Company, at its Pittsburgh, Cal. (U.S.A.) plant. The steel was made by the electric process and it analysed approximately as follows:—Carbon, 0.35 per cent.; sulphur, 0.02 per cent.; phosphorus, 0.004 per cent.; manganese, 0.75 per cent.; and silicon, 0.35 per cent. Under ordinary steel-foundry operating conditions it would have been impossible to obtain the continuity of the casting lining and to secure a steel which would weld to the casing in which it was cast. After the operation was completed, the two sections of the casing were successfully assembled, and there was only a difference of 3/32 in. between their dimensions as repaired and the original size.

# Sweeping a Casing Pattern in Plaster-of-Paris.

By J. R. Moorhouse.

The casings shown in Fig. 1, were moulded from plaster-of-Paris patterns, and at a great saving in pattern costs compared with the conventional method of working a pattern and core box. The plaster patterns were for master castings, those shown in Fig. 1 being the actual metal patterns used for repetition moulding. The casings were only ¼ in. in thickness, and of a very irregular shape. To ensure the metal being uniform would have required numerous templates and careful work if made in the orthodox manner.

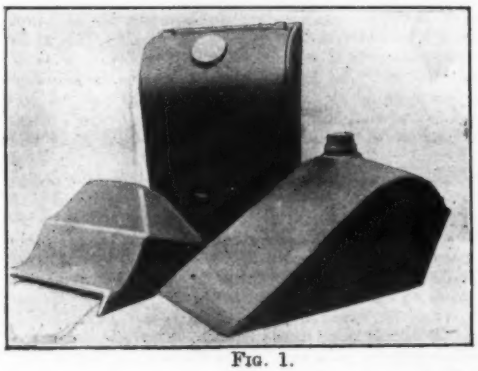

Fig. 1.

The principle employed in constructing the plaster pattern will be clearly seen by reference to Figs. 2 to 6. A drawing was first laid down, the full size of the section through the casing. As an example the casting marked A, in Fig. 1, will be described, one section through this particular casing being shown with other details in Fig. 6. From these sections all positions for the sweeps were obtained and to simplify the method of construction as far as possible, it was found advisable to utilise sweeps for sweeping the surfaces, in preference to working to templates, for the reason that the thickness of the plaster could be more readily obtained in the former than in the latter case.

Referring to Fig. 2, the foundation of the inside shape of the casing is shown built up on a strong bottom board, large enough to more than take the size of moulding box in which the pattern was to be moulded. Where the plaster was to be placed, rough-cut laths about ¼ in. thick and 1 in. wide, were so placed as to allow no less than ¼ in. thickness of plaster, and were kept apart so as to form a bond and keep the plaster in position. In this particular case it was necessary to raise the head part of the casing to bring the boss on the crown perpendicular to the base, so that it would mould without any difficulty. This will be made clear from Figs. 4 and 5. It will also be noticed in Fig. 2 that the sides were extended and formed into an arc, agreeing with the inside section of the casing at the centre. It is therefore evident that the plaster when swept up at this part would be true to the layout at the centre section. At a point just below this will be noticed a circular strip of wood overlapping the laths. This formed a guide for the sweep to work on, the other end of which worked on a straight piece shown in Fig. 3, which depicts the plaster swept up and ready for the crown to be shaped to the template from the three points given by the sweeps.

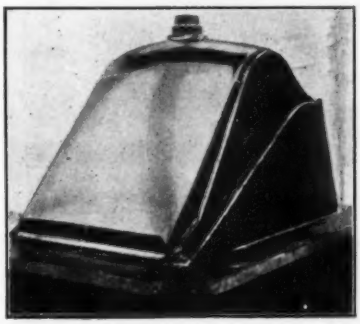

Fig. 5.

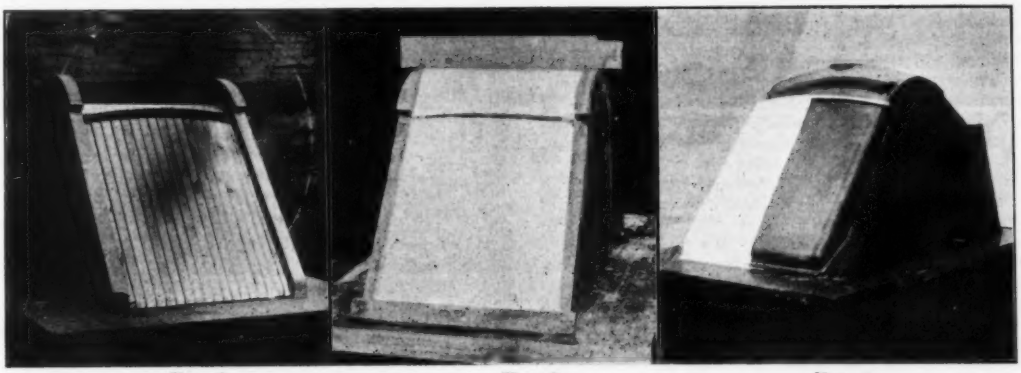

Fig. 2. Fig. 3. Fig. 4.

The boss shown on the crown in Fig. 4, to form the recess in the inside of the casting, was readily located and fixed by transferring the centre line from

the base, and striking out a circle a trifle large, and enclosing with putty to form a recess into which was run the plaster. This was finished off to the required size, and finally the whole given two coats of shellac varnish.

It then remained to form the pattern proper, and run on the plaster forming the metal thickness. For convenience in handling and moulding these were made in sections, one of which is in position

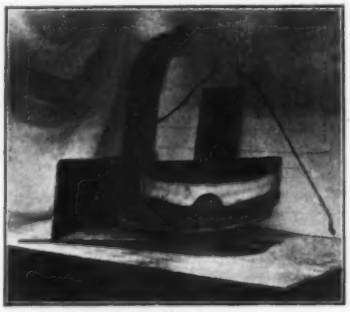

Fig. 6.

in Fig. 4, and completed in Fig. 5. The same procedure was followed as previously, with the use of sweeps and templates, care being taken to coat the inside form with tallow to make the joint and permit the sections to leave readily. These are shown in Fig. 6, removed from the inside form. The straight sections were made out of wood, and protected with two coats of varnish.

## British Foundrymen's Association.

### Sheffield Branch.

The Sheffield and District Branch of the British Foundrymen's Association held its annual dinner at the Grand Hotel, Sheffield, on Thursday, February 19, Mr. Thos. H. Firth (Branch-President) being in the chair. The gathering included the Lord Mayor of Sheffield (Col. G. E. Branson), Dr. W. Ripper (head of the Engineering Department at Sheffield University), and other gentlemen of note.

Dr. Percy Longmuir, in proposing the toast of the "City and Commerce of Sheffield," said that while the trade of Sheffield had been undoubtedly built to some extent on the traditions of the past, the manufacturers of the city had been always ready to incorporate with the experience gained in the past the fruits of present-day research. If that plan were continued in the future the commerce of Sheffield need have no fear, for it was only by linking up the experience of the past with the fruits of current research that progress could be made.

The Lord Mayor responded to the toast, and referred principally to municipal matters.

Mr. J. C. Ward (a director of Messrs. Edgar Allen & Company), who also responded, said that given a fair field, decent legislation and no favours, Sheffield manufacturers would continue to hold their own in the markets of the world.

Dr. W. H. Hatfield, in proposing the toast of "The University of Sheffield," said that the iron and steel industry of the city was of such a scientific nature that in the days to come it would need all the assistance which the the University could give to it. Technical education in Sheffield was extremely indebted to Dr. Ripper, who, through all the period of the evolution of the University, had been the head of the Technical Department.

Dr. W. Ripper, in the course of his response, said he thought no reference to the University should omit the name of the present greatly respected acting Vice-Chancellor, Dr. Hicks, who might be called the Father of the University. When he thought of the early days of the work of scientific education in Sheffield and then looked at the work being done to-day, he was filled with astonishment. In the very early days he had a large class of engineering students in a very dirty, dingy room, in the old Mechanics' Institute. There was so much interest taken in those days in science and there was so much belief in the future of science that when the Gilchrist Lecture Association offered lectures in Sheffield they were readily welcomed. Out of the great enthusiasm brought about by those lectures came the building of Firth College, an example of the beneficence and far-seeing wisdom of the late Mr. Mark Firth. The work had gone on until to-day Sheffield had not only a College but a University. But the colleges themselves, while they could do a great work, must not be expected to be competent to do everything. He always impressed upon technical students the fact that the purpose of their work as students was to get a thorough grounding in scientific knowledge and training, and that atfer that, before they would be of any real value in the world, they had to gain that practical experience which, combined with science, made the useful man. The works themselves would probably be called upon, as the result of the needs of the time, to take more care in the future to train up the young men who came to them from the colleges.

Mr. H. F. Cope proposed the toast of "Our Guests," and to this the Town Clerk replied.

Dr. T. Swinden, in submitting the "Kindred Associations," said there were some who considered there were too many technical societies in existence, but he thought those who were engaged in attempting to see a little deeper into the mysteries of metallurgy, could only say there were too few.

Mr. H. Brearley, in responding, said they knew that no branch of science or art or handicraft could be hedged around and placed in watertight compartments, and the kindred societies had got a wealth of information systematised, to offer to the comparatively young British Foundrymen's Association. The foundryman was a craftsman to whom little had been given and of whom much had been expected; he had had to make bricks as it were without the provision of straw, and he had made none such bad bricks at that. If the professional members of the Foundrymen's Association were to get to the bottom of the foundryman's difficulties, they must get their hands into the sand without troubling too much about the contour of their trousers and the colour of their hands. One was not entitled to determine for any particular foundryman the kind of angle of vision which he should take with respect to his own particular problems. All that could be hoped for, and all that one had a right to demand of an individual who undertook the study of foundry problems, was that he should keep his eyes open. Somebody had said that "Knowledge is found in heads replete with thoughts of other people; wisdom in minds attentive to their own."

Mr. H. C. Else, in giving the toast of the "British Foundrymen's Association," said that many present were men who had to use the foundrymen's castings, and although he could not speak about a casting with scientific knowledge he could tell whether the castings he was getting wore well or not. (Laughter.) Consequently, it was of the greatest importance that those present should learn something about the actual use of the castings as well as making them scientifically.

The President (Mr. Thos. H. Firth), in responding, asked for the co-operation of the managers of large works to get, not only their foremen, but their workmen, their moulders, to attend the lectures.

# Application of Town Gas to Core Ovens.

In a Paper on "The Application of Town Gas to Existing Core Ovens," read on January 27 before the Sheffield Branch of the British Foundrymen's Association, Mr. J. R. Hyde said his experiments with gas firing on an extensive scale might be regarded as a practical application based on theoretical calculations and possibilities. The use of gas-fired core ovens for small cores was by no means a new idea. Ovens so heated had been found of great convenience for drying small cores wanted in a hurry, but the gas consumption for the work done was high, and the life of the oven notoriously short, for the thin plates forming the sides were readily eaten through by the oxidising blue flame. However, the low price of gas in Sheffield was so much in one's favour that three years ago he decided to experiment in regard to drying all the foundry's cores overnight by means of town gas in the permanent brick core stove. Some who were familiar with steel works' practice would no doubt suggest producer gas, but a producer required lighting up and really more skilled attention than the old fire grate, in addition to which was to be considered the danger due to the highly poisonous nature of producer gas.

The experimental stove was 12 ft. by 6 ft. by 6 ft. 6 in. high, built of brick sides and roof, and its capacity was 50 cores about 8 in. diameter, with smaller ones in between, giving a total weight of two tons of cores to be dried. In order to get some idea of what the gas burner had to do, he proceeded to get at the weight of water which had to be evaporated. This was readily done by weighing all standard cores when wet and again after drying, and with a coal fire it was found that those nearest the fire lost the most weight. These were taken as a guide. The proportion lost was one-eleventh of the weight, and, although a little of that might not be water, yet the amount was so small as to be safely classed as water so far as the calculations were concerned. It was decided, then, that one-eleventh of two tons had to be evaporated, this amount being 420 lbs. As a gallon of water weighed 10 lbs., it was obvious that there were 42 gallons of water to be evaporated.

Much gas was not required to evaporate one gallon of water if that water was in a metal vessel which was a good conductor of heat; but when the water was absorbed in a substance which was a bad conductor of heat, his theoretical calculations received a shock. The heat value of Sheffield gas was about 560 B.T.U. per cubic foot, and in theory 1 lb. of water should be evaporated by two cubic feet. The Gas Company recommended two burners, each consuming 150 ft. per hour, and these were fitted in the stove. The burner and mixer was a very simple affair, consisting of a gas nozzle fixed inside a large reducing socket, the small end of the socket being joined on to the burner, which in this case was 1¼ in. gas pipe drilled with ¼ in. holes. The interior of the stove required to be re-designed to enable the heat to get round each core. Therefore, the shelves were pulled out, and a rack arrangement of light girders was put in. First the uprights of 3 in. by 2 in. girder were drilled through the web at intervals of 4 in. to take ⅞ in. bolts, and then secured in floor and roof. The ⅞ in. bolts were fixed across at such distances as suited the heights of the cores and horizontal rails laid on them, so that a skeleton took the place of shelves. They thus got a very compact arrangement, and the small spaces left between the core plates proved ample for the circulation of the hot air.

So far so good, but here the cost question entered. Lighting up at 6 p.m. and turning off at 7 a.m. next morning equalled 13 hours' gas at 300 cubic feet per hour, or a total of 3,900 ft. This gas, at 1s. 3d. per 1,000, equalled 4s. 10d., which was seriously above the cost when using coke, which was between 2s. and 2s. 2d. for drying two tons of cores. On putting their troubles to a representative of the Gas Company, he consoled them with the fact that they would no doubt be using over half a million cubic feet per annum, and therefore they would get their gas at 1s. per 1,000 ft. This would bring the cost down to 3s. 10d. per night. It occurred to the writer, however, that this could be reduced by running up the stove temperature to 200 deg. C., keeping it there for six or eight hours and then cutting off the gas, when the heat in the walls, plates, etc., would finish the work and leave the stove at a reasonable temperature for entering at 7 o'clock next morning. When burning the gas throughout the 13 hours they had found the stove too hot to enter for some time the following morning. As the eight hours during which it was now desired to burn the gas would end about 2 o'clock in the morning, when there would be nobody about the place, some mechanical device was required to cut off the supply at that time. Eventually he hit upon an appliance. A ⅜ in. iron rod was passed through the square end of a gas cock, a hook formed at the lower end, and a cast-iron weight fitted on the upper end. The apparatus was supported just out of the vertical, and retained in position by a string passing through the hook to another hook on a table. A nick was cut about ⅜ in. from the bottom of a carriage candle, and the string passed through the nick so as to bring it into contact with the flame when the candle had burnt down almost to the bottom. The flame cutting the string allowed the weight to fall, cutting off the gas in so doing. The candles used weighed six to the pound, and lasted 7½ hours, so that a big or a little candle was fixed according to the number and weight of the cores to be dried. In eight hours 2,400 ft. of gas was burned, which cost 2s. 6d., and as this dried two tons of cores it was considered satisfactory. The candle cut-off had been useful and reliable, as there was only one instance in three years of its burning the string and cutting off the gas before the time calculated, and that was owing to careless fixing. The other failures, such as the flame missing the string and the tap sticking, just resulted in the cores getting more fire than was really necessary, but the temperature did not get high enough to burn or injure the cores in any way, and no disorganisation of the foundry followed. Another type of cut-off was made from an alarm clock, by using the alarm device to set the weight in motion.

The reliability, combined with uniform drying, was undoubtedly the great asset of gas firing, and in each individual case it had to be decided how far this would compensate for the extra cost. The stove was also much cleaner. This was not very apparent to an outsider who was not well versed in degrees of dirtiness, but there was no soot deposited. So far, then, gas firing was a refinement. It was further found that by using a well-distributed gas flame cores could be used in a condition which many would term skin-dried, *i.e.*, in a core 8 in. in diameter

the thoroughly dried part extended 2½ in. inwards, leaving the centre still moist. An extremely interesting incidental advantage was that all the coke used then went either into the cupolas or fires for ladle drying, and was charged against melting expenses, so that the fuel ratio could be checked. This meant that the cupola man's efficiency was very readily checked, and it was probable that what was lost in core drying was saved in melting. It was obvious that gas firing was at some disadvantage in not giving high temperatures economically for drying big cores, but, by leaving in for two nights, big stuff could be dried without burning. The arrangement of girder shelving lent itself readily to alterations to make room for special cores.

Summing up and giving judgment on the first oven installed three years ago, Mr. Hyde said he could not do better than apply the test recently advocated by Mr. Buchanan for experimental cupolas, etc. That test was this: "If you were building another, would you put in this type?" His answer was that another stove had been put in eight months after the first, and a third also put into action just recently; and by putting a separate cut-out at a cost of 5s. on each gas supply, drying could be regulated to a nicety and economy secured.

The CHAIRMAN, in opening the discussion, remarked that the first thing Mr. Hyde had set himself to ascertain in tackling the problem was the weight of water to be evaporated. How many foundry foremen ever thought of that? They stuck a core in and dried it, but how often was it thought that the efficiency of a stove could only be judged by first ascertaining the work it had to do? He (the speaker) admired the cut-off device. If they could get as high efficiency from any plant they were using as Mr. Hyde was getting from that apparatus they could sleep content.

MR. CHOPE asked whether a governor was attached to the gas supply so as to regulate the pressure. As a rule, the pressure increased late in the night. Also, was a separate meter used to ascertain whether the stove was burning the quantity of gas it was supposed to do. The pressure of the gas varied very considerably.

MR. JOHN LITTLE said that at the works with which he was connected all the cores were dried from a supply taken from the gas producer, which was common to the furnaces. He did not see how he could apply the arrangement described by Mr. Hyde, though it would be very valuable to know how much gas the stoves were taking from the common main. The design of the stove described by Mr. Hyde should appeal to all people dealing with small core work.

MR. J. F. MASON said Mr. Hyde had showed them how he had very effectively evaporated the water, but now how he got rid of it. This was a very important point, because if the air became saturated (the saturation, of course, would be proportional to the temperature) no more evaporation would take place except by introducing fresh air into the oven. Mr. Hyde had mentioned the high temperature necessary to evaporate the water out of the cores. That, of course, was due to the fact that the evaporation on the outside of the cores reduced the water inside to a very low temperature.

MR. HYDE, in reply, said the arrangement of the meters at their works was such that the supply could be shut off from everything but the stoves, and he had always adopted that method when taking the consumption tests. Variation of gas pressure was certainly a factor. During the cold weather some little time ago they had trouble due to the pressure falling so low that the gas was hardly sufficient to do its work properly, but by paying a little attention to the jets they were able to overcome the difficulty. But if the gas pressure varied from ¾ in. of water up to 2½ in. it made no difference to the action. They simply got a longer blue flame and more heat, but there was no firing back. In regard to coke stoves, there were small coke stoves on the market, which he believed gave very great satisfaction. Of course, where a steel-works producer-gas supply was available, the matter was nearly as easy as turning on the tap at the main. With regard to the efficiency of the candle, there was nothing whatever to go wrong. With regard to ventilation, he said the oven used was an existing core oven. It was originally designed for an ordinary coal fire stuck in the floor, and the burnt gases were taken out by a chimney within 6 in. of the floor. That gave a reasonable circulation. All they had done, as far as that was concerned, was to stop up three-quarters of the chimney. The burning of 300 cubic feet of gas per hour meant that 3,000 cubic feet of air and gas were being brought in per hour, and the other air must get out through the nicks and crannies without being specially catered for. The other stove which they had put in had no ventilation whatever, and it was, if anything, more satisfactory than the first. With regard to Mr. Mason's remarks, most foundrymen would have met this action in the "striking damp" of cores and moulds when they had been skin dried—they had a habit of becoming moist again. That was due to the water from the inside coming out. But that, of course, was a thing which a practical foundryman would very soon get to the bottom of. If he found his cores striking damp he knew he must have a higher finishing temperature, or give the cores longer in the stove.

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### Annual Meeting of Sheffield Branch of British Foundrymen's Association.

The annual business meeting of the Sheffield Branch of the British Foundrymen's Association was held on January 27, Dr. Percy Longmuir presiding, in the absence of the Branch-President (Mr. T. H. Firth). The Secretary (Mr. Robt. W. Kemlo) read the report of the committee for the year 1913. It stated that the year showed an increase in membership. Five full members, 17 associate members, and eight associates, a total of 30, had been elected. Unfortunately, 17 members had been struck off the register owing to non-payment of subscriptions, and two had left the district. The membership now was 106, as compared with 95 last year. During the year, six meetings had been held, and the attendance on the whole had been good. The report was adopted, on the motion of the Chairman, who said that on the whole it was an extremely good report, one of the most gratifying features being that 30 new members had been elected.

The CHAIRMAN then proposed the re-election of Mr. T. H. Firth, as Branch-President, which resolution was carried unanimously.

MR. JOHN LITTLE proposed the re-election of Alderman Samuel Osborn as senior Vice-President, and Mr. James G. Crowther as junior Vice-President. Mr. J. R. Hyde seconded, and the motion was carried.

Mr. R. W. Kelmo was re-elected as hon. sec. and treasurer, and also as special delegate to attend the meetings of the General Council in Birmingham. Messrs. W. H. Oxley and J. R. Hyde were elected auditors, and the retiring members of the Committee (Mr. H. Pilkington, Dr. T. Swinden, and Mr. J. E. Short) were re-elected, three vacancies being filled by the election of Messrs. F. Darley, John Little and J. T. Goodwin.

# Green-Sand Moulds.*

By H. R. Shackleton.

As is well-known, those moulds that are made in various kinds of sands and retain their own moisture till poured or cast, are termed green-sand moulds. This method is, without doubt, the one for making the majority of castings in ordinary foundries doing work in connection with modern engineering.

Skin-dried moulds are those which are rammed up in green-sand, and are then dried skin-deep, after being cleaned up and washed with wet blacking. It will be seen that by skin-drying a mould, the moisture on the surface or face of the mould is reduced to some extent. Skin-dried moulds often give sounder and much cleaner castings than do green-sand moulds, and when cast do not generate as much steam and gas, and are therefore less liable to give blown or scabbed and dirty castings. There are moulds which it is absolutely necessary to skin-dry, owing to their intricate and delicate construction; such moulds are better able to withstand the flow and force of the molten metal in passing down the runner and then over the face of the mould at the time of casting. Reducing the moisture on the face and walls of a mould also stiffens the green-sand cores, and there is not the same likelihood of particles being washed up from the face and the walls of the mould as with green-sand moulds.

Dry-sand moulds are those which are rammed up in the same way as the ordinary green-sand mould, very little regard being given of the amount of moisture the sand contains, so long as the mould will retain its true form and shape. These moulds should be vented to a certain extent in precisely the same way as green-sand moulds, for although there is no moisture to evict or force through the walls of the mould, there is always a certain amount of gas generated in the sand at the time of casting, which will pass and escape through the vents, without any marked effect. When not vented, sometimes these moulds explode or ignite their gases before the pouring or casting is finished, and the shock causes the face or top of the mould to suffer by small pieces being shaken off, the result being a dirty and unsatisfactory casting, only fit perhaps for the scrap-heap.

Loam moulds are swept up by strickles or striking boards, which revolve around brickwork built roughly to the shape of the intended mould; plastic loam is applied to the brickwork, and is struck on or off, as the case may be, by the striking board or strickle, which revolves on a fixed centre for cylindrical work. The porosity and cohesive properties of loam are obtained by grinding strong sand with water and adding horse manure to give porosity and also claywash and hair for cohesion, or bond. The material is ground to the required state of strength and porosity, and the moulds are blackwashed and dried before casting.

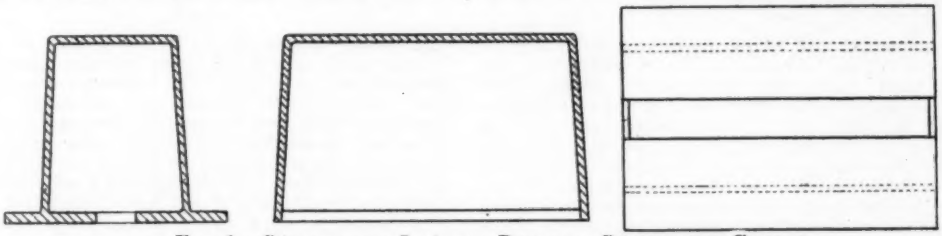

FIG. 1.—SECTIONS AND INVERTED PLAN OF A STEAM-CHEST CASTING.

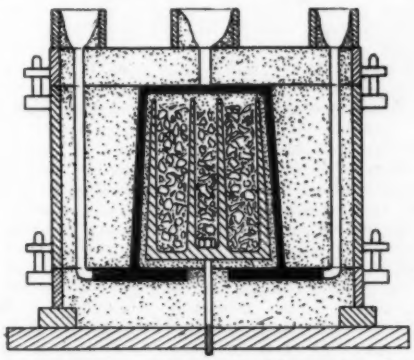

FIG. 3.—SECTION OF ASSEMBLED MOULD FOR CASTING SHOWN IN FIG. 1.

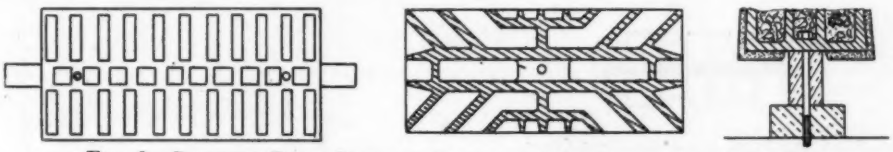

FIG. 2.—INVERTED PLAN, SECTIONAL PLAN AND CROSS-SECTION OF CORE IRON.

When moulding in green sand, those sands that are charged with moisture above a certain limit should not be used, as any attempt to pour hot metal into a wet mould will immediately generate dangerously large quantities of steam and gas,

* Prize Essay before the Keighley Association of Engineers.

and the molten metal will not lie on the bottom or face of the mould, gases and steam causing it to be blown or forced back through the runners and risers just after casting. A mould of this kind is no good whatever, but serves to show the danger of an excess of moisture in green sand used for moulding. No extra amount of venting will ensure a sound casting in such circumstances, and even did the casting appear to be a success, there would be trouble with machining and fitting, and the

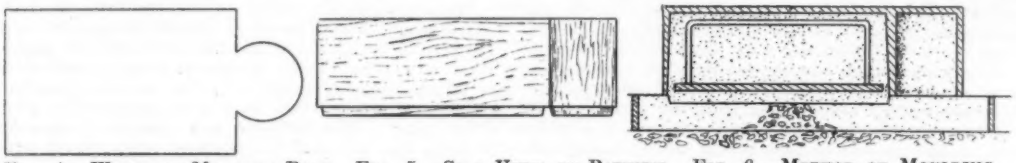

FIG. 4.—WEIGHING-MACHINE BASE. FIG. 5.—SIDE VIEW OF PATTERN. FIG. 6.—METHOD OF MOULDING.

castings would not stand the strain sometimes required of them, being too hard and brittle. On the other hand, sand rather too dry will not bind, but will fall and crumble away; or if it did stand in the mould, it would very likely be washed away from its position by the force of metal passing from the runner into the mould. It is evident then, that sound judgment and experience combined are required to determine the amount of moisture to be used in the making of clean green-sand moulds, which will readily discharge the air and gases, and cause no trouble with the moulder or anyone concerned.

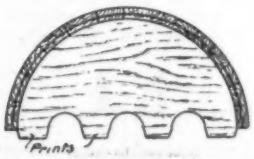


FIG. 7.—SIDE SECTION OF SOLID PATTERN FOR GEAR CASE.

Facing sands for green-sand moulds call for a large amount of study for various classes of work. Strong or new sands, when ground in the sand mill, increase in bond, and if they are ground too long, are entirely unfit for facing sand, so it will be seen that a weak sand may be made strong, and a strong sand may be made stronger, up to a certain point, providing there is the necessary amount of moisture present. Sands that contain no clay or bond, or what may be termed sharp or washed sands, are those which must be used to give the required porosity. The sand must retain its shape or form in the mould, so as to give a good face on the casting, and also be so porous that the air and gas may be driven out of the mould without any obstruction whatever, at the time of casting, thereby allowing

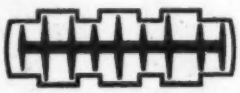

FIG. 9.—CORE IRON FOR GEAR-CASE CORE.

the metal to lie at rest. Some castings require to have a very fine and smooth surface, these being, as a rule, light and of various descriptions. Scotch sand is a suitable moulding material for this work; it is very high in clay or bond, and when mixed for facing sand, along with a certain amount of coal dust, requires only a very small amount of milling, which is mostly done by treading it over with the feet. This sand must be used rather dry if good results are to be obtained, and the pattern must be used very clean, or "clagging" will result. The vent wire must be used on all drag or bottom parts if good results are to be obtained, as this sand when rammed up is very impervious to air and gases unless thoroughly vented. Lancashire red sand is difficult to use to get good results, and the writer cannot recommend it for any particular class of work. Yellow sands are more even in their bond and porosity and are mixed in varying strengths. to suit nearly all classes of foundry work. Mansfield sands are among the best of moulding sands, and generally serve where other sands fail, as when moulding wheels of a fine pitch and also of large diameters. This particular sand will stand when other sands fail by not having sufficient bond or strength to stand the flow and force of metal when casting. Where Mansfield sands are used, the

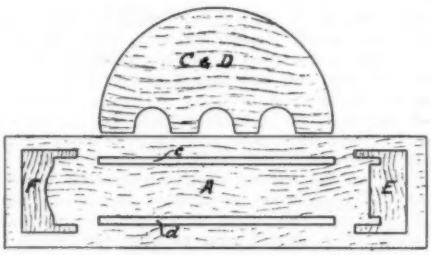


FIG. 8.—CORE BOARD AND FITTINGS FOR MOULDING GEAR CASE.

floor, or old, sand has a much longer life, and also may be worked with a larger percentage of moisture than any of the above-mentioned sands, by being more open or porous. Finally, all foundry sands are affected by atmospheric changes; in other words, an intricate casting may be made to-day with ease and to-morrow may be quite difficult. Also, the finer or closer the sand and the higher the per-

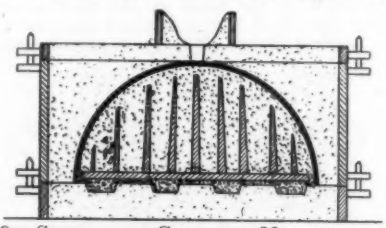

FIG. 10.—SECTION OF COMPLETE MOULD FOR GEAR CASE.

centage of clay the greater the risk of the casting being blown or scabbed, and also the greater the time required in venting the mould compared with an open or porous sand.

The accompanying sketches describe the making of some green-sand moulds. Fig. 1 shows sections and inverted plan of a pattern of a kind of steam-chest. The core for this casting requires some provision to be made for holding it together in the mould, and also to keep it from being lifted or moved while the metal is being poured. Fig. 2 shows the core iron, bottom side, with two lugs which rest on a couple of bricks before being bolted down to the bottom bar shown in Fig 3. This is simply a flat plate with a screw-hole in the centre, which takes a screw-bolt and holds the core from rising. The core iron is prodded almost to the depth of the inside core, as shown in Fig. 3, and these prods help to stay or hold the inside core together, and also the small coke or breeze which is placed in the middle of the core to assist in making the green-sand core as light as possible. This mould is entirely built on a coke or cinder bed, so that every facility is given for the core to discharge its gases. The secret of making this class of casting is in the use of a clean, open or porous sand. On the first occasion on which the writer saw this casting made the core was not bolted down, but chaplets placed on the core instead, and when they were bored and plugged the casting showed a certain amount of porosity, and was, therefore, rejected.

In Figs. 4, 5 and 6 is shown a base for a platform weighing-machine, with the inside core made in green sand and lifted direct from the core-box into the core-print in the mould. The round section is made in dry sand, as it is much smaller to dry in the core oven.

It may be mentioned that the base for the platform weighing-machine, and also the gear case, are only moulded this way till standard patterns are available, which leave their own cores in green sand when the pattern is withdrawn from the mould.

In Fig. 11 is shown a sewing-machine hollow arm which is moulded in an ordinary two-part box. This arm is entirely hollow, and the green-sand core is made at the time the pattern is rammed up, the pattern leaving its own core. This core is entirely carried on the core iron A. As this core has no bearing, except at one end, to keep it from rising and falling a weight is cast on the core iron, which is bedded, or rammed, in the drag part of the box, and is thereby kept stationary till cast. This mould is made with two sand joints, termed a rolling joint.

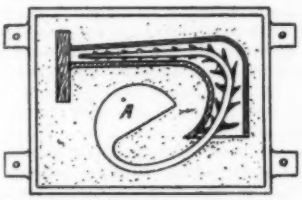

Fig. 11.—Moulding a Sewing-Machine Arm.

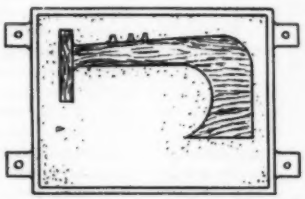

Fig. 12.—Pattern in Mould.

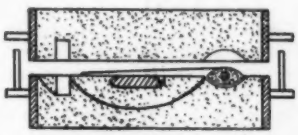

Fig. 13. Section through Mould.

Figs. 14 to 17 illustrate the moulding of a moulding-machine body. Owing to the construction of this pattern not being entirely satisfactory, the method shown was adopted. All the inside is lifted out on the core plate as shown; the core plate is lifted out and then the pattern is withdrawn from the mould. Next, the portion of sand under the boss pattern at the right-hand side of Fig. 14, has to be cut away before the bottom flanges can be withdrawn, which causes a lot of time to be wasted. The writer would rather withdraw the flanges when ramming up, and cover with a dry-sand core, as shown at the left-hand side, Fig. 14. This method makes a better casting. In Fig. 15 will be seen a half-section of the same casting; the boss is made or put together by two cores made in a core-box. Fig. 16 is a plan showing core-print of the same method, while in Fig. 15 it be seen that all the inside is entirely lifted out on the core plate. Fig. 17 shows a plan of the core-plate.

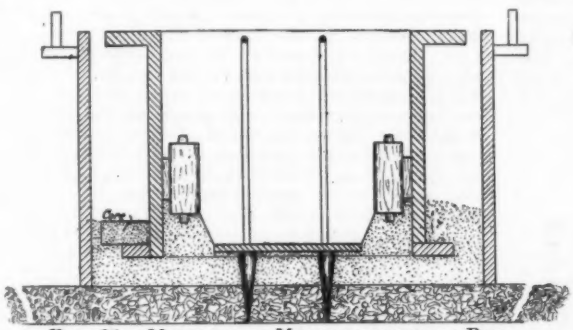

Fig. 14.—Moulding a Moulding-machine Body.

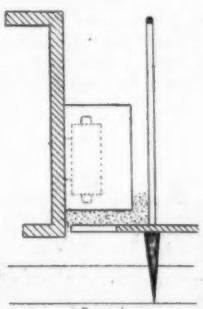

Fig. 15.—Showing Method of Placing Boss.

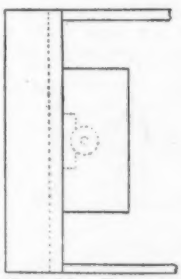

Fig. 16.—Plan of Core Print for Boss.

Fig. 18 depicts a half-section of a pulley and shows how the patterns are made in wood, while in Fig. 19 is a sketch of the two halves of a pulley in their respective positions in the cope and drag parts of a moulding box, which method is preferable where time is of any consideration. It is also far

In Fig. 7 is shown a side section of a solid pattern of a gear case, which does not require any particulars as regards moulding. In Fig. 8 is shown the core-board A, and on this board, at *c* and *d*, fit boards C and D. The cramp E holds the two sides straight up. F is the sweep or strickle. The core iron is seen in Fig. 9, while Fig. 10 is a section of the complete mould of the gear case, ready for casting.

better to withdraw a pattern from the mould than to withdraw a top part of a mould from a straight and sometimes rough pattern. In Fig. 20 is shown a system of moulding a web pulley, where the web is loose, and also the bosses, which are set by a gauge to the depth of pulley required. Assuming

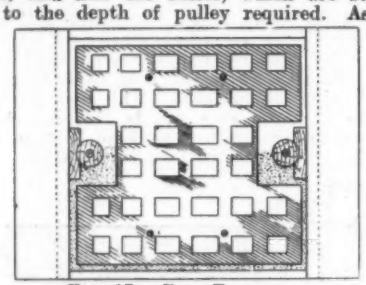

FIG. 17.—CORE PLATE.

that the pattern is rammed up as shown, the outside rim is withdrawn first, the cope is put on, the core-iron staples are scotched up, bringing the inside core and also half of the boss which is loose. The bosses are withdrawn, the mould is then cleaned up and finished and closed ready for casting. In Fig. 21 is shown a flanged pulley, and also the finished mould, which is made in an ordinary two-part moulding box. This method gives as good results as when made in a three-part box, providing the boss is a little wider and deeper. Sometimes flanged pulleys are made by a pattern having a core-print all the way round the outside pulley face. After the pattern is withdrawn from the mould, a dry-sand core is then inserted in sections, stopping out all but the intended flange. But the method shown is preferable.

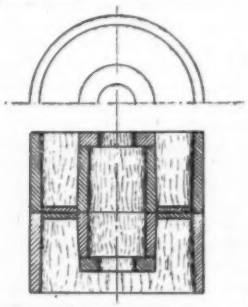

FIG. 18.—PULLEY PATTERN.

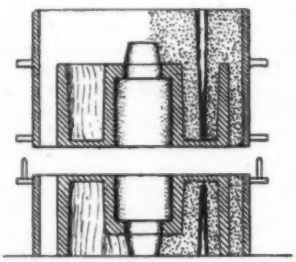

FIG. 19.—METHOD OF MOULDING PULLEY.

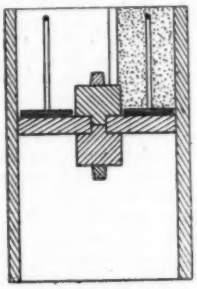

FIG. 20.—MOULDING A WEB PULLEY WITH LOOSE WEB.

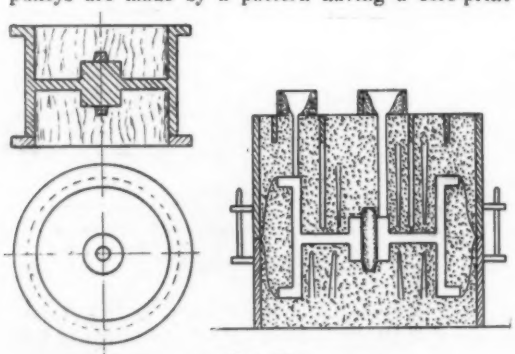

FIG. 21.

## Scrap Tool Steel Reclamation.

In a Paper before the American Railway Tool Foremen's Association, Mr. J. J. Sheehan remarks that in common parlance any tool steel which is no longer serviceable for the purpose for which it was originally intended falls within the accepted meaning of scrap tool steel. This material, at least, as far as the average shop is concerned, cannot be remelted, since this would mean a complete change in the structure, but can be transformed into other tools of different shapes and sizes without altering its original characteristics and value as a tool steel. In the shops of the Norfolk and Western Railway tool steel is, for convenience, divided into four grades. As tools become too short or unfit for further service, they are placed in the scrap bin provided for the purpose, corresponding to the number on the tool. When a sufficient quantity of scrap tools has been accumulated it is then sent to the smith shop, weighed, receipted for, and placed in bins in the steel workers' section labelled grade 1, grade 2, grade 3, etc., corresponding to the grade of the scrap. This department is equipped with a furnace that will maintain a heat of 2,500 Fahr., with a re-heating chamber attached suitable for annealing purposes. There is also a 1,200-lb. steam hammer for the work of the department. This work should be handled by an experienced steel worker, otherwise the results will not be satisfactory. When a sufficient quantity of scrap of grade No. 1 has been accumulated, it is placed in the preheating chamber of the furnace, and allowed to heat slowly and uniformly to a dark red, about 1,000 deg. Fahr.; the steel is then transferred, at the convenience of the tool smith, to the other chamber and brought to a bright red heat, 1,550 deg., and forged to the required size. Pieces 1¼ in. by 3 in. are forged to 1¼ in. by 2½ in.; 1¼ in. by 2½ in. to 1 in. by 2 in.; 1 in. by 2 in. to ⅝ in. by 1 in.; ⅝ in. by 1 in. to ½ in. by ½ in. and ⅜ in. by ⅜ in. sizes. After forging and dressing for service, the steel is placed in the annealing box and allowed to cool before hardening to relieve the forging strains. From 600 lbs. of scrap steel thus treated there are usually 500 lbs. of serviceable tools delivered to the tool room, at a reclamation cost of 2½d. per pound. From the service rendered, they are the equal of tools made from the original bar; hence the reclaimed value of the steel after deducting the cost of reclaiming, 2½d. per pound, is 1s. 10½d. per pound. By this systematic recovery of scrap tool steel and following a plan of utilising the material for the smaller sizes and shapes for which it is perfectly applicable, there is an opportunity under ordinary conditions of saving a great deal of tool steel.

# Cupola Design and Operation.

Before a recent meeting of the Halifax Branch of the British Foundrymen's Association, Mr. E. L. Rhead (Manchester) lectured on "Some Considerations in the Design and Working of a Foundry Cupola." He said that the design and working of foundry cupolas had for a long time been a bone of contention, all manner of faults being credited to the cupola. In his opinion the inability of the operator to understand its fundamental principles was the chief trouble. First and perhaps most important (at least where heat was concerned) was to clearly define between the heat and temperature of cupola. Temperature and volume of heat should not be confused. It was possible to have a very high temperature without great heat. Fuel burnt in a furnace was capable of producing heat relative to weight, and had a direct bearing on the efficiency of the cupola and the ease with which metal could be melted. It was possible to develop heat and get the maximum results by putting it to a proper use, or a large amount of heat could be developed and a lot of it be lost, improperly-burnt fuel bringing with it bad results and metal not sufficiently fluid for good castings.

The rate at which heat could be developed and the ease with which it could be applied, depended upon the quantity of air, how it was applied, and how the gases were distributed in the cupola. Every pound of fuel put inside a furnace required a definite amount of air to burn it, and every lb. of fuel would produce a certain amount of heat, and all this heat should be used, as far as possible. The question resolved itself into this, that for economical working a furnace to do the work efficiently was necessary. If hot metal was wanted speedily, fuel saving could be considered afterwards. Alterations to lining, tuyeres, etc., would have to be made so as to give as far as possible perfect distribution of gases, to get the heat absorbed and keep the furnace working in a steady fashion. If the tuyeres supplied air at so small a pressure that it only penetrated a little way into the cupola, the tendency of the air to ascend the sides of the cupola would be greater than it would if the pressure was greater, and lacking air in the centre, dull iron would result. The pressure should be sufficient to get a good distribution all over the furnace. Properly distributed, the blast should reach the centre.

Boshed furnaces were correct in theory, but the earlier methods of carrying out the idea diminished the diameter with the same blast pressure as before. It was obvious that the blast went nearer the centre, and the gases had a tendency to go nearer the sides, and supply every portion of the cupola with hot gases, pre-heating the material in a better manner. It should also be borne in mind that near the tuyere holes the cold air coming into the cupola had to be heated, this being the first demand on the fuel. If the contraction in the shape of the cupola was near the tuyeres, and the air thus only partially heated, this had the effect of chilling partially-heated material and helped in the arching over of the furnace. The contraction theory was sound but unsafe. The remedy lay first of all in raising the contraction some distance above the tuyeres and thus chilling would be prevented because the air would have to travel through a large amount of fuel, while the metal would slip through into the melting zone and be speedily melted. The projection would depend upon the diameter of cupola and the material which was fed into it. Heavy material and a small cupola would require a diminished projection, as it prevented the blast from creeping up the sides of the furnace. With large cupolas and light material the projection could be made larger. This was the essence of success, and the original idea was only faulty because it was carried out too near the tuyere area. The contraction should never be brought below the place where melting began.

With regard to the shape of the furnace, in many cases they were bellied out immediately below the contraction. This shaping of the furnace was the result of observations taken after melting. The lining suffered most where the heat was greatest and the idea was to give the lining that shape which it took naturally. This looked all right at the first sight, but chilling was more likely to take place under these conditions. The argument in favour of the practice was that the slight belly was more than compensated for by the expansion of the material, but it was not so; a by-pass for air would be left up the sides of the cupola because everything had to pass through a narrower area in coming down and would not fill up the sides. It might reduce the amount of daubing, but it lowered the efficiency for perfect melting.

All recesses in the even face of the lining should be avoided, and such as were caused by careless lining or daubing; there was naturally too ready an escape for the gases up the sides, which were always less densely packed than the centre; therefore, any recesses in the lining only aggravated a natural fault and gave readier access to the escape of hot gases instead of these being distributed right through the mass of stock. For rapid melting the shape of the cupola must be kept good, a bad shape being the surest way of getting a "stuck" cupola. Discussing next the height of the cupola in relation to diameter, Mr. Rhead said it was impossible to get a lot of iron down a small furnace, a sufficient space being required for the amount of fuel which had to be burnt. This should be determined by the rate at which the stock took up air. Under perfect conditions, the gases should be cool at the charging door; if in a cupola the gases were blazing at the charging door, or if when they struck any projection such as a rivet head, they show a blue flame, these gases were escaping at about 540 deg. Fah. (the ignition point), and perfect conditions were not obtained. These conditions could be secured by regulating the height of the cupola, the ratio being up to 4 ft. diameter, about 5 to 1, and in larger cupolas about 4 to 1.

With regard to the air supply of cupolas, this depended on the form, size and disposition of tuyeres, pressure and distribution of blast. Small tuyeres meant slow melting and dull metal. The tendency of modern practice was to enlarge the tuyeres, but there was no hard and fast rule; different cupolas were working under different conditions with different blowers and using different material, and the tuyere area which would suit one cupola would not suit another. The actual tuyere area should be arrived at by actual experience. As a general idea, with medium material and a 4-ft. 6-in. diameter cupola, the best tuyere area for economy and securing metal of a good heat would be one-seventh of the sectional area of furnace. The pressure was equal to a column of water 21 in. high. If the tuyere area was too big, and the blast pressure let down, this would be responsible for many failings, because the blast would not get into the material, and if the pressure was kept up, too much fuel was burnt and the metal would come down too fast if sufficient fuel was put in. If too little fuel was put in then the metal came down impoverished. It was better to have sufficient tuyere area, because the area could

be made less, though it was very difficult in many cases to increase it, should it prove too little. All modern manufacturers were working that way, but there were so many fads among inventors that careful sifting was required to find out the best working design.

The old style of pipes, which entered straight into the furnace, one on each side, making but two tuyere holes and these opposite to each other, though not the worst method, failed to give a good distribution of air, and the disposing of any piece of metal which might have lodged opposite to one of the tuyere holes became a serious matter. If this could not be got rid of mechanically, it meant closing that tuyere until that obstruction had been melted. This was no easy matter when the air had all to be driven in at one place. From the point of view of distribution, still retaining two tuyere holes, to place them so that they did not enter opposite each other was a slight improvement. Some had tried running the tuyere holes into the furnace slantingly, but this had a tendency to drive the air round the sides.

With regard to the air belt, when this was inside the shell he could not see any advantage in it except for the patent rights, but an air-belt outside was all right. This made for a more uniform distribution of air and an increased number of tuyeres. The use of numerous tuyeres was good, provided the blast pressure could be kept up right to the nozzle. To assist in maintaining the pressure the tuyeres could be narrowed down to the point where they entered the furnace. He (the lecturer) was painfully aware of the greater risk of a tuyere "making up." It was not an accident; a lump of coke developed heat and would burn, but not so a lump of metal with cold air blowing on to it; instead of melting the metal it chilled it. The remedy was to close the tuyere until the iron was removed. There was a good deal of misconception about an upper row of tuyeres. If enough air could be admitted and a sufficient pressure got with one row, by all means that should be done. The arguments in favour of the upper row would not hold water. It was said that the upper row of tuyeres helped to burn the gases, but the fact of those tuyeres burning $CO_2$ was of no consequence; the thing that counted was that the top row was burning coke and the melting zone was being lifted higher. A double row of tuyeres was unnecessary, unless sufficient air could not be got with one row. It was significant that the manufacturers of furnaces with more than one row of tuyeres made special mention of the fact that doors were provided so that the upper rows could be closed if necessary. A third row of tuyeres further increased the difficulty. If it was found necessary to use the second row, the direction of the upper row should be downward. The tuyeres should be large enough to admit sufficient air and numerous enough to distribute the air, and if they were multiple should concentrate on the melting zone so that the gases could be distributed for pre-heating.

Finally, it was essential to see that the slag came off properly, and as height of tuyeres above the hearth determined where the slag hole should be, it would be more fluid and run off more readily if it had not to creep high up the cupola. Tuyere area and blast pressure determined economical cupola working and the height of tuyeres above the bottom of the furnace had some bearing upon it. If the tuyeres were near the bottom and the cupola was large enough to supply the shop, they were satisfactory. The nearer they were to the bed the better; metal was cooled by standing on the bottom. If hot metal was wanted, the tuyeres should be kept low.

### Discussion.

Mr. S. G. Smith, in opening the discussion, referred to the statement made by Mr. Rhead with regard to boshed cupolas. His impression was that the contracted shape of cupola was to assist in carrying the burden and had no relation to distribution of blast. Did it not appear somewhat foolish where a rather large furnace was desired to brick it in and lose diameter. With most air-belts there was no control of the tuyeres. He thought it would be a deal better if every operator had complete control of each tuyere, then if a piece of metal lodged in front of one he could at once close the tuyere and get rid of the obstruction by using the others. He had seen where two rows of tuyeres were used a cupola arched right over, bearing out what the lecturer had said. The height of the slag hole should always be determined by the amount of metal it was desired to keep in the well. He, too, thought that spiral tuyeres were a hindrance to efficient cupola working. He knew of two cupolas which were built in the North of England with tuyeres circling right to the top, but to-day not one of those extra tuyeres remained up.

Mr. Berry agreed with the lecturer regarding the regulation of height of cupola to diameter to bring about perfect cooling of gases, but many foundries had to make their furnaces to suit their buildings.

Mr. Robinson, with regard to the upper row of tuyeres, said he had still only one row working after having bricked up the other, and was getting very good results.

Mr. Rhead, in replying, said Mr. Smith was perfectly right in his impression regarding the contracted cupola; in the first place it was to support the burden, but Ireland got such good results (presumably by accident) that they came to be utilised. One firm was making a success of a cupola with three rows of tuyeres, these being placed so as to blow all the air into the bed, and by the time one layer of coke was burnt another layer was down. He thought with Mr. Smith that it would be much better for the operator to have full control of the tuyeres. In answer to Mr. Berry he was aware that too often the height of the shop determined the height of the cupola. It was a case of the cupola being built for the shop and not the shop for the cupola.

### Titanium in Bessemer Steel.

A report on an investigation of the influence of titanium on ingots and rails made from Bessemer steel treated with ferro-titanium after blowing, was submitted by Mr. W. H. Wickhorst at a recent annual meeting of the American Railway Engineering Association. A series of seven Bessemer heats was made, treated with varying amounts of ferro-titanium. To summarise the results, the use of amounts of 0.1 per cent. or more of metallic titanium prevented the honeycombed condition of the upper part of ingots found in plain Bessemer steel, but was also attended with a larger and deeper pipe. The heavy segregation or concentration of carbon, phosphorus and sulphur found in the interior and upper part of ingots of plain Bessemer steel was largely avoided, but the mild negative segregation found in the interior and lower part of the ingot was not materially altered. The brittle zone found in rails of plain Bessemer steel from the upper part of the ingot, as determined by drop and tensile tests, was avoided, but the properties of the rail from the lower two-thirds of the ingot were not changed. Large internal flaws were found in rails considerably lower than from the top of the ingot with steel treated as mentioned than in rail made from plain steel.

# Calculating Cost of Production in Iron and Steel Works.*

By C. Canaris.

Every business manager owes it to his employers to do all he can to see that his department is as profitable as it can be; and in order to accomplish this result, he needs not only a thorough technical education, but also a knowledge of commercial matters, and must display a lively interest in works book-keeping and calculating costs of production. The object of the present report is to introduce these questions into the series of subjects discussed by the Steelworks Committee, and at the same time to demonstrate that the subject, which is regarded by many as a difficult one, is comparatively simple when examined more closely. The author does not claim to bring forward much that will be new to those of long experience, or that the principles and methods set out are necessarily the best; but as his experience has been wholly in new steel works, he has had to start the system of book-keeping in all cases, there being no previous system to go upon. Briefly, the points to be dealt with in keeping books to show the working of any department are the following:—Wages; quantity and cost of materials; quantities consumed, produced and delivered; together with calculations of the cost of production, and the preparation of comparative tables of various kinds.

*Booking Wages.*—This is a comparatively simple affair, and well known in practice, so that it need not be dilated upon, except to state that books are now largely being replaced by cards, which are much more convenient.

*Booking Supply and Cost of Materials.*—Every consignment of raw material received is on the basis of some contract at a settled price, either with an outside firm or another department of the same works. Each contract has a number which must be given on all consignment notes, waybills, etc.; and the contracts are booked in serial order, preferably on the card system, each card bearing the number of the contract, with the name of seller, quantity, price and term covered, date of consignment and delivery, truck number, dispatching station, weight on consignment note and on works weighbridge, freight and charges, including demurrage, and a column for remarks (shortage of weight, etc.).

*Consumption, Production and Delivery.*—The weights of each kind of material used must be noted and forwarded to the works office daily, where the quantities used in charging the furnaces are entered in the usual form of account. For the sake of control it is also advisable to book the daily consumption of all other materials, such as coal, refractory materials, etc., in special books. None of these particulars furnished direct from the working operations should on any account be employed as a basis for calculating the cost of production, since these data are found by experience to be far from reliable, being usually below the truth. The only reliable basis for determining the quantities consumed is stocktaking, which should be very carefully done at the beginning or end of every month. The actual consumption will be found by adding the material received during the month to the balance in hand at the previous stocktaking, and deducting the actual stock. An example of the method is given in Table I.:—

TABLE I.—*Consumption of Dolomite for the month of January*, 1913.

| | Tons. |
|---|---|
| Stock on January 1 .. .. .. .. | 100 |
| Received during January .. .. .. .. | 440 |
| Total .. .. .. .. .. | 540 |
| Stock on January 31 .. .. .. .. | 120 |
| Consumption in January .. .. .. .. | 420 |

To ensure accuracy, it is desirable that the various consignments (of known weights) be kept distinct, and that one parcel be used up before another is broken into. Any estimates of stock should be made with great care, and understate rather than overstate the truth.

The determination of the production is made on the same lines, the stock at the beginning of the month being subtracted from the sum of the deliveries and the stock at the end of the month, as in Table II:—

TABLE II.—*Production for the month of January*, 1913.

| | Tons. |
|---|---|
| Stock on January 31 .. .. .. .. | 850 |
| Deliveries during January .. .. .. | 13,700 |
| Total.. .. .. .. .. .. | 14,550 |
| Stock on January 1 .. .. .. .. | 550 |
| Production in January .. .. .. .. | 14,000 |

The goods sent out should be carefully weighed on machines which are frequently tested, and every possible means taken to ensure accuracy. These reliable data are booked in the manner shown in Table III., which also gives the money value of the materials consumed. The chief items, namely, stock, quantities received and amounts consumed, should also be entered in a summary book, which is a book that should be kept by every works engineer, because of the immediate information it furnishes, in a very succinct form, about the consumption, stock and prices of the various materials.

TABLE III.—*Specimen of Summary Book.*

| SCRAP ACCOUNT. | Weight. | Price per ton. | Total Value. |
|---|---|---|---|
| | Tons. | s. d. | £ s. d. |
| Stock on January 1, 1913 .. | 6,800 | 57 0 | 19,380 0 0 |
| Received during January .. | 6,375 | 59 0 | 18,827 10 0 |
| Total .. .. .. .. | 13,175 | 58 0 | 38,207 10 0 |
| Consumption in January, 1913 .. | 7,775 | 58 0 | 22,547 10 0 |
| Stock on February 1, 1913 .. | 5,400 | 58 0 | 15,660 0 0 |
| Received during February .. | 5,925 | 60 3 | 17,813 19 4 |
| Total .. .. .. .. | 11,325 | 59 1½ | 33,473 19 3 |
| Consumption in February, 1913 .. | 7,120 | 59 1½ | 21,039 12 0 |
| Stock on March 1, 1913 .. .. | 4,205 | 59 1½ | 12,434 7 3 |

The figures obtained in this way enable the cost of production to be calculated with ease. Table IV. gives an example of a form which shows the cost of

* Communication from the Steelworks Committee of the German Ironmasters Association; published in "Stahl und Eisen."

production for a working period of one month; and this should be sufficient for all requirements. The figures are only typical, for the sole purpose of affording an example of the way the calculation should be made, and are not to be taken as representing the actual data from any steelworks. The item, "works scrap" refers to the rolling-mill scrap and that from the forgings, that produced in the steelworks itself being grouped as "foundry waste." In some works the different grades of scrap are booked separately; but experience shows that great difficulty is experienced in large works in keeping these separate and estimating them accurately, for which reason all the purchased scrap has been lumped together in the example given.

"Producer coal" refers solely to the coal consumed in heating up and running the producers. Coals for smithies, locomotives and heating ladles are booked as a separate item, even when the last-named are heated with producer gas. "Refractory material" comprises all bricks and sand except those used for repairs, and therefore includes flue bricks, hopper bricks, ladle linings, plugs, and sand for fixing the furnace plates and facing the ladles. The consumption of these materials is ascertained by stocktaking, whereas that for repairs is estimated at a certain amount per ton of output—in the present example at 9d. per ton of ingots. The consumption must, however, be checked by stocktaking at the end of each quarter. The same applies to the items "moulds" and "spare parts." The "cost of conversion" represents the difference between the cost of production and the cost of charge materials per ton of output. This method of calculation is followed in some works, but in others the difference between the cost of production and the average price per ton of charging materials is taken as the cost of conversion. In the present example this average price is 63s. 6d. (Table IV., col. 4).

General expenses, depreciation and interest have not been included in the calculation, since, in the author's opinion, they do not come under the head of cost of conversion. He prefers to set down the amount estimated for general expenses separately, and to take the sum of this and cost of production as "cost of production, including general expenses." In any case it is essential that the works manager should be advised every month by the head office what share of the general expenses has been debited to the account of his department.

It has already been mentioned that certain important items, such as cost of conversion and coal consumption, are calculated differently in different works; and this helps to explain the highly divergent figures given at times for these items. Some even confine the coal consumption to the amounts used for smelting the charges, leaving out of consideration under this item the amount used in heating up the furnaces and keeping them hot; whilst others group the smithy and locomotive coals along with the producer consumption, hence extensive differences in the statements of coal consumption.

Finally, statistical charts are useful, for example, those showing the length of service of each furnace, the stoppages for repairs and how long shut down, for the year, these being shown by different methods of hatching or colouring, and accompanied by numerical data.

TABLE IV.—*Cost of Production in an Open-hearth Steelworks, using the Scrap Process.*
PRODUCTION, 14,000 TONS. NET YIELD, 90 PER CENT. SCRAP, 2 PER CENT. WASTE, 8 PER CENT.

| Percentage of charge. | Material. | Weight. | Cost per ton. | Total cost. | Proportional cost per ton. Itemised. | Proportional cost per ton. Total. | Consumption |
|---|---|---|---|---|---|---|---|
| | | Tons. | Shillings. | £ s. d. | Shillings. | Shillings. | Cwts. |
| 25 | Pig-iron | 3,887.5 | 77 | 14,966 17 6 | 21.38 | — | 5.56 |
| 2 | Ingot-mould scrap | 311 | 70 | 1,088 10 0 | 1.56 | — | 0.45 |
| 50 | Purchased scrap | 7,775 | 58 | 22,547 10 0 | 32.21 | — | 11.12 |
| 20 | Works scrap | 3,110 | 58 | 9,019 0 0 | 12.88 | — | 4.42 |
| 2.5 | Foundry waste | 388.7 | 50 | 971 15 0 | 1.38 | — | 0.54 |
| 0.4 | Ferro-manganese | 63.5 | 200 | 635 0 0 | 0.91 | — | 0.09 |
| 0.1 | Ferro-silicon | 14 | 250 | 175 0 0 | 0.25 | — | 0.02 |
| — | Aluminium | 0.3 | 1,500 | 22 10 0 | 0.03 | — | — |
| 100 | Total charge | 15,550 | 63.57 | 49,426 2 6 | 70.60 | — | 22.20 |
| | Less casting waste produced | 310 | 50 | 775 0 0 | 1.10 | — | 0.44 |
| — | Cost of charge | 15,240 | 63.84 | 48,651 2 6 | — | 69.50 | 21.76 |
| — | Iron ore | 98 | 20 | 98 0 0 | 0.14 | — | 0.14 |
| — | Lime | 560 | 10 | 280 0 0 | 0.40 | — | 0.8 |
| — | Limestone | 140 | 4 | 28 0 0 | 0.04 | — | 0.2 |
| — | Calcined dolomite | 420 | 25 | 525 0 0 | 0.75 | — | 0.6 |
| — | Magnesite | 28 | 70 | 98 0 0 | 0.14 | — | 0.04 |
| — | Tar | 7 | 50 | 17 10 0 | 0.02 | — | 0.01 |
| — | Producer coal | 3,500 | 14 | 2,450 0 0 | 3.50 | — | 5.0 |
| — | Smithy coal | 4.2 | 15 | 3 3 0 | 0.04 | — | 0.066 |
| — | Locomotive coal | 30 | 12 | 18 0 0 | | | |
| — | Coal for heating ladles | 12 | 12 | 7 4 0 | | | |
| — | Refractory material | — | — | 490 0 0 | 0.70 | — | — |
| — | Do. for repairs | — | — | 525 0 0 | 0.75 | — | — |
| — | Moulds, &c. | — | — | 490 0 0 | 0.70 | — | — |
| — | Wages | — | — | 2,100 0 0 | 3.0 | — | — |
| — | Salaries | — | — | 140 0 0 | 0.20 | — | — |
| — | Electricity | — | — | 210 0 0 | 0.30 | — | — |
| — | Spare parts | — | — | 35 0 0 | 0.05 | — | — |
| — | Stores | — | — | 245 0 0 | 0.35 | — | — |
| | | | Total | £56,410 19 6 | 11.08 | | |
| — | Deduct for slag | 1,900 | 3s. | 285 0 0 | 0.40 | — | 2.71 |
| — | Cost of conversion | — | — | — | — | 10.68 | — |
| — | Cost of production | — | — | — | — | 80.18 | — |
| — | General expenses | — | — | £1,050 0 0 | — | 1.50 | — |
| — | Cost of production, including general expenses | — | — | — | — | 81.68 | — |

# Electric Production of Chromium, Tungsten, Molybdenum and Vanadium

In a Paper read before the American Electro-Chemical Society, Mr. Robert M. Keeney, of the American Bureau of Mines, discusses (*inter alia*) the reduction of chromite by carbon, silicon, aluminium, and calcium carbide; also the available ores and raw materials and the process of manufacture. He remarks that the electric furnace used in the manufacture of ferro-chrome may be one of several types, all on the principle of the Siemens crucible with a conducting hearth, or similar to the Héroult steel furnace, with vertical electrodes in series.

The process of manufacture of ferro-chrome, he continues, consists of mixing a charge of chromite and anthracite coal in proportions based upon the theoretical calculations given. This is shovelled into the open top of the furnace around the electrodes. The furnace is charged at regular intervals so as to keep the top in a solid condition. The ore is very finely powdered, but the coal is about as it comes from the mine. There is some loss by ore being carried off with the gases which escape at the top of the furnace.

The ferro-chrome is tapped from the bottom, at intervals of from two to four hours, into iron pots set on trolleys, from which it and any slag are dumped when solid. The slag and metal come out of the same tap hole. When cold the metal is broken up with hammers to separate it from the slag and packed into kegs or boxes. For tapping an iron rod is used to open up the tap hole, which is plugged with fire clay.

Ferro-chrome manufacture is carried on continuously, in some cases for two years before shutting down the furnace for repairs. In one operation, directly from ore, ferro-chrome containing down to 5 per cent. carbon can be made economically. It has been possible to produce an alloy containing as low as 2 per cent. carbon in one operation, but great care is necessary in the regulation of the charge and the operation of the furnace. The slags from the average ferro-chrome furnace making a 5 per cent. carbon alloy run from 0.5 to 1.0 per cent. $Cr_2O_3$.

The author then discusses the refining of ferro-chrome, and goes on to describe some experiments made by him in 1912 on the production of ferro-chrome from chromite with carbon as a reducing agent. The conclusions drawn are:—(1) that ferro-chrome can be easily manufactured directly from chromite in the electric furnace; (2), that the percentage of carbon in the ferro-chrome cannot be kept low by regulating the carbon charged without excessive loss of chromium in the slag; (3), that the percentage of carbon in the ferro-chrome must be regulated by decarburisation with an oxide slag of iron or chromite after tapping off the slag from reduction; (4) that silicon and phosphorus cannot be kept low in the alloy under the strong reducing conditions necessary: (5) that sulphur can be easily slagged; (6) that, as the addition of lime does not seem to aid in removing phosphorus, it is advisable to use no lime, but as pure raw materials as possible; and (7) that the power consumption should not exceed 3.7 kw.-hours per pound of ferro-chrome tapped, or 0.85 kw.-year per ton. Some further notes on power and electrode consumption are added.

The author next takes up ferro-tungsten, giving historical notes, theoretical considerations of the reduction of wolframite, ferberite or scheelite with aluminium, silicon or carbon, and describes the process of manufacture as follows:—Ferro-tungsten is manufactured from ores in three ways:—(1) by direct reduction with carbon in a crucible; (2) by reduction in an electric furnace by some agent other than carbon; and, (3) by direct reduction with carbon in an electric furnace.

In manufacturing ferro-tungsten by the crucible process, concentrates are placed in a clay-lined crucible with the proper proportions of reducing agent and flux, and heated to a high temperature in a gas-fired furnace. There is considerable wear on the crucible in this method. For a 30 per cent. tungsten alloy the crucible will last about three heats, but for a 65 to 75 per cent. product they last but one heat. Higher percentage tungsten alloys than this are not made in the crucible furnace.

In the electric furnace process, ferberite, wolframite, hubnerite or scheelite are reduced with carbon in an arc furnace. As with many expensive alloys, the process is generally an intermittent one, *i.e.*, the reduced charge is tapped from the furnace before another charge is added, or the charge is let solidify and chiseled out of the furnace. Sometimes a campaign of several days is made. The reduced alloy is either decarburised with refining slags in the same furnace or melted and refined later in another furnace. The furnaces used are similar in design to the ones described for ferro-chrome production, but a more complete recovery is effected by the use of a tilting rather than a stationary furnace. Wolframite, ferberite and scheelite are reduced easily in the electric furnace, most of the manganese being volatilised. Scheelite is more difficult to reduce, and very sticky basic slag results. There is a greater loss in its reduction, so that it does not command as high a price as the other ores, selling for about 4s per unit less. The product is tapped into moulds, broken up on cooling, and packed into kegs or boxes.

The author describes some experiments made by him on the reduction of ferberite with carbon to produce ferro-tungsten in the electric furnace. From the experiments the following conclusions are drawn:—(1), Ferro-tungsten can be produced directly from ferberite in the electric furnace; (2), by the use of a decarburising slag before tapping, the percentage of carbon in the alloy can be kept below 2 per cent.; (3) manganese, silicon, phosphorus and sulphur do not enter the ferro-alloy in high percentages; (4), the loss of tungsten in the slag need not be excessive, and (5), the power consumption need not exceed 3.46 kw. hours per pound of ferro-tungsten tapped, or 0.79 kw.-year per ton.

The commercial manufacture of ferro-molybdenum is carried on in an electric furnace of the electrode type operated as a resistance furnace, or in a crucible furnace of the resistance type. Comparatively little ferro-molybdenum is made because of difficulty in getting ores. This is due to the fact that satisfactory methods of concentration for molybdenite ores have not been fully worked out as yet. Buyers require an ore or concentrate containing 90 to 95 per cent. molybdenite.

In commercial manufacture, raw or roasted molybdenite, iron turnings, lime and coke or coal are mixed to give a ferro-molybdenum of desired proportions, and treated in the electric furnace. The furnaces are operated intermittently, *i.e.*, one charge is com-

pletely discharged before another is added. Ferro-molybdenum is first made as a high-carbon alloy containing 3 to 4 per cent. carbon. This is then decarburised with a lime slag or a slag of lime and iron oxide. If the latter is used the percentage of iron in the alloy is increased.

From some experimental work of the author on the electric smelting of molybdenite the following conclusions are drawn:—(1) Ferro-molybdenum low in carbon can be made directly from molybdenite in the electric furnace, with excess lime as a desulphurising agent and carbon as a reducing agent; (2) a product of low percentage carbon can be made, and (3) sulphur can be readily slagged as calcium sulphide with a charge of excess lime.

Most of the ferro-vanadium made is produced by the thermit process, by reduction of the oxide $V_2O_5$ in a crucible with carbon or by reduction of vanadate if iron with carbon in a crucible. In Europe some ferro-vanadium is made by reduction of the oxide, sulphide or vanadate of iron with carbon in the electric furnace. The largest source of vanadium is the Peru deposit of patronite, a sulphide of vanadium containing about 60 per cent. sulphur and 20 per cent. vanadium.

Patronite ore is first roasted and then reduced by the thermit process. Or, in the electric furnace it may be directly reduced with lime as a desulphurising agent and carbon as a reducing agent. The other ores are treated by chemical or ore-dressing processes to obtain the vanadium as oxide or vanadate of iron, and then reduced with carbon in a combustion or electric furnace or by the thermit method. With oxide the electric furnace method is similar to the production of ferro-tungsten with carbon as a reducing agent. The sulphide reduction is similar to that of molybdenite with lime and carbon. Several methods have been patented using silicon as a reducing agent in the electric furnace.

## The Time Duration of Crucible Melting.

By Norman Swindin.

The following calculations which arose recently from a chance question whether the time required to melt one hundredweight of brass in a graphite crucible could be ascertained theoretically, may be of interest to some readers :—

Consider first the time required to melt a cylinder of brass weighing 112 lbs., say, 6 in. diameter by 12 in. high, without the crucible. It is assumed the cylinder be placed in a glowing coke fire at a temperature of 2,400 deg. F., and that the melting point of the metal is 1,832 deg. F.

Q = total heat of fusion of 112 lbs. brass.
Q = latent heat of fusion + sensible heat.
Latent heat = $112 \times 60$ = 6,720 B.T.U.'s.
Sensible heat = $112 \times 0.092 \times 1{,}832$ = 19,100 ,,
Sp. heat °F.
$\therefore$ Q ... ... ... ... = 25,820 ,, ... 1

Then if N = B.T.U. transmitted to the cylinder per minute,

$\theta_a$ = initial temperature difference between the coke fire and the cylinder in deg. F.

$\theta_b$ = final temperature difference in deg. F.

$\theta_m$ = mean temperature difference in deg. F. (see below).

K = co-efficient of transmission in engineering units, *i.e.*, B.T.U. through a cube 1 ft. edge per sec. per deg. F. (for brass K = 0.0137).

A = area of heated surface in sq. ft.
T = thickness of equivalent plate in ft.,
H = time in min. required to melt cylinder, then

$$N = K \frac{\theta_m A}{T} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad 2$$

and $$H = \frac{Q}{N} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad 3$$

The exact meaning of the term "mean temperature difference" is not yet agreed upon by engineers. It is usually understood to be the difference of temperature between the two surfaces, but Hausbrandt, in his work "On Evaporating, Condensing and Cooling Apparatus,"† goes fully into the question and concludes that temperature changes do not follow straight-line laws, but are better represented by the hyperbola. Hausbrandt's formula is thus :—

$$\theta_m = \frac{\theta_a - \theta_b}{\log_e \frac{\theta_a}{\theta_b}}$$

In our case, if the cylinder of metal at 60 deg. F. be instantly plunged in the fire at 2,400 deg. F, then

$\theta_a$ = 2,400 − 60 = 2,340° F.
$\theta_b$ = 2,400 − 1,832 = 568° F.

and $$\theta_m = \frac{2{,}340 - 568}{\log_e \frac{2{,}340}{568}} = 1{,}250° \text{ F.}$$

The values for A, the area and T, the thickness, are obtained by considering the cylinder as a plate of equal contents, with a surface equal to the cylindrical surface; thus the value for A is $\frac{19 \times 12}{144} = 1.6$ sq. ft., and for T is $\frac{330}{228 \times 12} = 0.12$ ft.

Working out formula 2 we get :—

$$N = \frac{0.0137 \times 1{,}250 \times 1.6 \times 60}{0.12} = 13{,}700 \text{ B.T.U.}$$

Substituting this value in equation 3, the time required to melt the cylinder is :—

$$H = \frac{Q}{N} = \frac{25{,}820}{13{,}700} = 2 \text{ minutes approximately.}$$

We see from this that the time required for the heat to penetrate the metal is insignificant.

Now as for the crucible, which would be 6 in. diameter internally and 12 in. deep inside, with a thickness, say, of $\frac{5}{8}$ in.

Let A = surface transmitting heat in sq. ft., T = thickness of walls $\frac{5}{96}$ ft., K = co-efficient of transmission in engineering units (for graphite K = 0.000029). The surface transmitting heat would be the surface of the outer cylinder plus that of the crucible bottom, *i.e.*, A = 1.92 + 0.208 = 2.128 sq. ft.

From formula 2 therefore we get—

$$N = \frac{0.000029 \times 1{,}250 \times 2.13 \times 60 \times 96}{5} = 90 \text{ B.T.U.'s.}$$

$$H = \frac{Q}{N} = \frac{25{,}820}{90} = 285 \text{ min.} = 4 \text{ hrs. } 45 \text{ min.}$$

The actual time required according to practice is only 2 to 2½ hrs., so that our calculated figure gives too high a result. It is to be remembered, however, that the co-efficient of transmission for the crucible is taken as being that of pure graphite. The ordinary graphite crucible of commerce is not pure graphite, and would have a co-efficient of heat transmission, of course, higher than that here taken. If K for the crucible be taken as 0.00005, the time of melting calculated would agree closely with practice.

The results of this investigation will interest those who are engaged in applying gaseous and liquid fuel to the melting of metals in crucibles.

† London: Scott, Greenwood & Co., 1903.

# The Reversal of Patterns.

By W. J. Horner.

Cases often occur where castings are required in pairs, right- and left-hand. It then has to be decided in the pattern shop whether two separate patterns shall be made or a single pattern reversed after it has been moulded. The course adopted depends on the size of the pattern, the number of castings required, and the amount of work involved in reversal as compared with that in two patterns. There

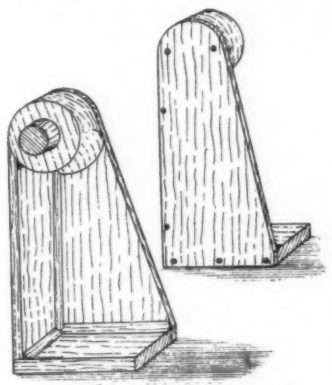

FIG. 1.—RIGHT- AND LEFT-HAND BRACKETS NOT INTERCHANGEABLE.

is also the question of possible future use after the castings immediately required are made, and the work involved and disadvantage of repeated reversals as compared with two separate patterns.

Those who are not very familiar with engineer's work will be able to see in Fig. 1 what is meant by right- and left-hand. A pair of brackets is shown of a type which frequently occurs in all classes of

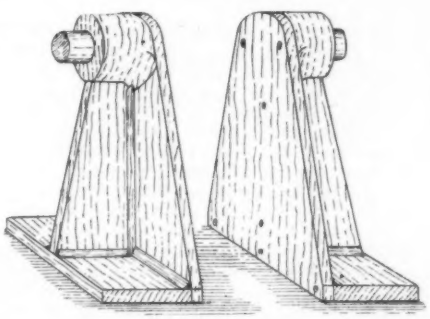

FIG. 3.—BRACKET SUITABLE FOR EITHER HAND.

work. The castings are not interchangeable, and it is rather troublesome to alter the pattern from one hand to the other. It will be seen that to do so necessitates taking out the fillets, unscrewing the foot, boss, and vertical rib, and replacing them all on the opposite side of the web. Even then the rib will not fit the boss unless its taper is planed the opposite way, with considerable reduction in thickness. The more usual course is to make a fresh rib if the pattern is small, or cut its end off square and fit another piece between it and the boss. The taper or draught required in patterns complicates reversal of the parts. In this case the edge of the web would require a shaving taken off to taper it the reverse way. There is often trouble, too, with screws coming too close to old holes. In Fig. 1 the same screw holes in the web would be used, but it would be impossible to have those in the other pieces exactly right for reversal. This should be remembered in making the pattern, for it is desir-

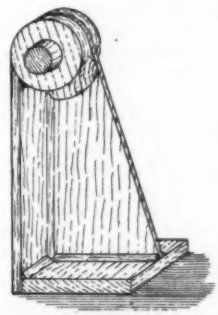

FIG. 2.—BRACKET SUITABLE FOR EITHER HAND.

able to use the old holes in the web rather than bore new ones. The screws seen in the farther bracket in Fig. 1 are not well spaced for reversal. The two in the boss should not be quite in a horizontal line, and the three in the foot should not be at uniform distances lengthwise. A very slight

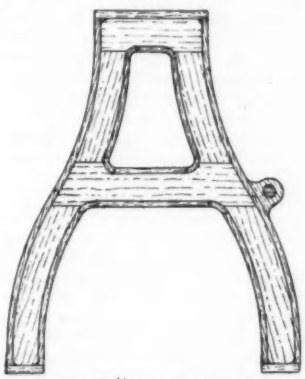

FIG. 4.—STANDARD EASILY REVERSED BY CHANGING THE LUG.

amount out of symmetry is sufficient, because this is doubled when the parts are turned the reverse way. Generally two separate patterns would be made in cases like Fig. 1, where reversal is so troublesome and the pattern itself comparatively simple.

In Fig. 2 is shown a bracket, the base and boss of which, in size and in relative positions, may correspond precisely with that in Fig. 1, but the bracket

is of a design which is reversible without altering the pattern. It is made reversible by having its web central instead of at one side. This, of course, is not necessarily an improvement. Other things have to be considered besides interchangeability. There is more work in the pattern in Fig. 2, and it is more troublesome to mould. The question of bolt holes in the foot may be affected by the different position of the rib.

Fig. 3 shows another common type of bracket which is correct for either hand without alteration, and is as convenient for moulding as that in Fig. 1. Its web is at the back, as in the first example, but is symmetrical in relation to the boss and foot. Its boss and foot might correspond in size with those in Fig. 1, but not in relative positions, and therefore it is not always possible to substitute the design in Fig. 3 for that in Fig. 1. The latter is a very common design, and there are always reasons why its foot is not central below the boss.

Fig. 4 is an example where the pattern can be altered to the reverse hand with very little trouble. We assume that the web of the standard in this instance has its ribs on one face only, as is usual in castings of this sort. The lug seen at the right hand side makes the casting unsymmetrical and necessitates right- and left-hand castings, one having the lug at the right, the other at the left, when the castings are viewed from the same face, because when the pairs are in position they are usually back to back. As it is easy to unscrew the lug from the pattern and screw it on the opposite side, and this change can be made dozens or scores of times if necessary, it is a case where it is seldom advisable to make two patterns, especially as there is considerable work in them. It may be convenient to make two lugs. Two complete patterns would be made only when such castings were constantly wanted, and a single pattern would eventually get worn out and another have to be made to take its place.

This would be a point to be decided in the pattern shop or foundry, because the design of the casting itself is such that no modification is worth considering. But in most castings which occur in pairs the design has first to be considered and a decision arrived at in the drawing office. If it is possible to make the castings alike and interchangeable, it is better than having two distinct hands which are not interchangeable, provided that no sacrifices are made or disadvantages incurred in obtaining uniformity. Generally it is better to make two patterns or to alter a single pattern than to avoid it by undesirable modifications in the design. These undesirable modifications may involve unnecessary metal, needless complication of design, or some sacrifice of strength or perfection of form for its purpose. There are instances where uniformity of castings is obtainable in right- and left-hand work by not attempting to cast too much in one piece. A portion can be cast separately and bolted on the main casting. This would not be advisable in the instance in Fig. 4, but it is easy to see how it might be done in that case, and how other work not very different in character might very well be treated in that way.

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Mr. A. Anderson, of Carron, speaking at the West of Scotland Iron and Steel Institute, stated that at his works they were using half-and-half of coal and coke by weight. This had resulted in a larger output. Very little progress had been made in the direction of increasing the production, taking the average of the blast furnaces in Scotland, but one or two had advanced. At the Carron works they had regularly made 2,200 tons of iron per week out of three furnaces, greatly, of course, due to the increased percentage of coke used.

## What of the Future Founder?

By F. G. Penny.

The foundry stands peculiar in its own characteristics, a realm within a realm, and until recent years an almost neglected centre—and this, though it is no new trade in the world of engineering, but rather one of the most ancient. It may be claimed to be among the most artistic, if unclean, and among the most significant and dignified, though belittled and neglected, of all arts and sciences of the engineering world.

But what of the future founder, who is the boy of to-day? So much depends upon the lad's capabilities, for every one entering a foundry is not likely to attain to the maximum capacity, even under the most disciplined and advanced tuition. The lad may have a good conception and yet be lacking in concentration and delivery, he may be a most apt follower, yet an inept leader; and hence from the many entries into the ranks but a small percentage only will reach the summit of universal qualification. If the country is to possess a large number of fully qualified founders, the young founder's initiation into the art, his aptitude, the method and duration of training and the general encouragements which should be afforded him, must all be considered at the outset of his life's work.

What has been the general method of training? In some instances there has been an absolute lack of method. Usually twelve months or less has been spent at the core bench, then a transfer has taken place to the moulding floor, and through it all, in many instances, his actual training has been neglected. In many cases, the highest ideals and fullest conception of his future life's work are bound up in the necessity of knowing how to construct his mould. If his moulds will stand this test he is considered a qualified man. Of course, this qualification is imperative if he would turn out castings commercially; yet such training is totally inadequate to meet present-day requirements, for from whence shall come the future supervising staff, foundry managers and foremen. The lad is taught to construct his mould, but what of the higher and all important issues behind it—the furnaces, cupola, crucible, converter, etc? Is there not a need for a close familiarity with the metallic side of his craft and a knowledge of manipulation which is quite as essential or even more essential than the construction of the mould?

Steel and iron, the gun-metals, the yellow and white alloys and manganese bronzes, all possess their own peculiarities and demand their own special treatment. Particularly is that the case with manganese bronze. There are thus numerous important and essential parts of the founder's art, without which no foundryman stands fitted for much beyond mould-building.

Let us then consider a system of training the future founder. On the lad's first appearance into the foundry, he should spend the first few days observing, and during the second week be placed at the core bench, where he should remain and receive every encouragement and facility to develope in this particular art. He should be questioned by his foreman, or perhaps the manager of the foundry occasionally, as to his methods of core making. His replies should be given in writing and retained to test his comparative growth of knowledge and also to supply the necessary information as to his aptitude to the trade. After serving 12 months at core-making (sand and loam) he should be transferred to the moulding floor, where for the first three months he should be employed, alone, on small and not too important work. The second three months he should work under the guidance of a good moulder, and the third three months be moved to other employment on a different class of work. For the fourth three months he should be put with another

moulder. This changing would instruct the lad in the different classes of work, and he would receive a variety of ideas from the various men worked with, preventing the possibility of falling into a stereotyped method of working. On entering his third year, he should be employed for the first six months alone, and with one of the most qualified moulders for the remaining six months of his year. He should then promise well to make a reliable man, providing he possesses the necessary aptitude.

In addition to this, however, it would be as well that from the commencement of his second year he should spend one week in every quarter at the cupola, crucible, or other furnaces and discharge his duties as though he were an ordinary furnace hand. (Of course, the physical strength of the lad must be considered.) This system of training would familiarise him with the metallic side of his work and would place at his disposal opportunities of developing knowledge obtained at evening classes.

The subjects that should form the basis of his studies at the evening classes should be drawing, chemistry and metallurgy, and if his term of apprenticeship should cover a period of seven years, he would have had furnace experience of 24 weeks (six months), and this, with the experience gained under the theoretical and practical conditions, should prove very fruitful. One cannot too highly appreciate the general laboratory training of the many scientific centres, but without fuller means of developing the knowledge, the laboratory training gained at such centres is not adequate to fit the young founder for the opportunities awaiting him.

Without reflecting upon or speaking disparagingly of the large army of supremely qualified moulders, whose productions are often fine achievements in founding, it would not be an exaggeration to say there is still a very great number whose cupola, crucible and other furnace practice has been narrowed down to the lowest possible limit—and this not through the fault of the men, but through lack of a standardised method of training. Many firms are very strenuously helping on the apprentice, but a fuller standardised method enforced on the entry of the lad and carried out during his term of apprenticeship would help to produce that desirable combination of qualities found in the qualified scientific practical founder. The writer feels strongly the importance of a higher foundry idealism and recognises that if the rapid engineering developments are to be fully coped with, deeper thought, finer appreciation of art, and a closer relation to science are necessary to keep touch with the growing intricacy of the trade. If some method of the kind suggested for the training of foundrymen were adopted the outlay in time would be remunerative, and the trade elevated generally.

## British Foundrymen's Association.

### Birmingham Branch.

The annual dinner of the Birmingham Branch of the British Foundrymen's Association was held at the Colonnade Hotel, Birmingham, on February 7, the Branch-President (Mr. C. Heggie) presiding. The large company included Mr. S. A. Gimson (President of the Association), Professor Turner (Birmingham University), Mr. F. Johnson (Birmingham Technical School), Mr. R. Buchanan (Past-President), Councillor George Ward (Birmingham City Council), H. Winterton and Mr. C. Grindlay (Hon. Sec.).

Mr. F. Johnson, proposing the toast of the "British Foundrymen's Association," said that they might take those initial letters as representing B—By-gone days; F—Future; and A—Achievements. He congratulated them on having created the Association, and on having developed it until it had attained a place in the forefront of institutions dealing with applied science. The history of the past ten years had been one of remarkable progress.

Mr. S. A. Gimson, responding, said that although that was the first Birmingham dinner he had attended, he had been a member of the Branch for many years. They regarded Birmingham as the birthplace of the Association, and one of the first to attain prominence was its first President, Mr. Robert Buchanan. He recalled also with gratitude the work done by Mr. F. J. Cook, Mr. Heggie, Mr. Winterton, Mr. Grindlay (the Secretary), and others too numerous to mention. He believed that although only ten years old, the Association was a very healthy and vigorous child. The membership had grown from 90 at the end of the first year, to 1,100 at the present time, and he believed it would grow so much in future that, eventually, everybody of the remotest importance in any foundry would feel bound to belong to the Association. Their object was to pursue an entirely educational course, and whilst, as employers, foremen and workmen, there were, of course, some differences of opinion and interests, they were there to master the technical and practical problems of the foundry. People sometimes spoke lightly of rule-of-thumb, but they must remember that that was based upon experience. In the presence of University men, he would like to say how much they appreciated the careful research work done for them by the experts, which must assist them in turning out sound castings. One of the essentials to future improvement in the foundry trade was greater care in the training of apprentices. A Committee of the Association was now engaged in collecting information as to the training of apprentices, and it was intended when that was complete to send it out in tabulated form, to all the members and at the same time, to invite suggestions. In that way they would get very valuable information. It was very desirable to make the most of the extremely useful period of youth, when the mind was capable of storing and making the most of information.

Mr. H. Everall, proposed "The Birmingham Branch," and Mr. C. Heggie, responding, said they sought to carry out the city motto of "Forward." They had had a fairly successful Branch, and they meant in the future to maintain Birmingham in its position as the leading Branch of the Association.

Mr. R. Buchanan proposed the toast of "Kindred Societies," and said the Association had found, as one of the younger societies, that the other bodies were very helpful to them. They welcomed especially with them Professor Turner, who had been a source of great strength to them, and who had greatly assisted them in the work already accomplished.

Professor Turner, responding, said Birmingham had been very prolific in the development of such societies. The Institution of Mechanical Engineers was founded in Birmingham, and for many years had its central premises in Newhall Street. The British Foundrymen's Association did not hold its first Convention in Birmingham, but it orginated among a number of his Birmingham friends, and so long ago as 1893, in a course of lectures given by himself, he strongly recommended the formation of such a body.

Mr. Gimson proposed the toast of "The City and Trade of Birmingham," and Councillor Ward responded.

# Discussion on Moulding in Loam.*

Mr. S. G. Smith, of Bradford, who had been invited to open the discussion, illustrated his remarks by lantern slides. The type of casting he had chosen for description was an internal-flange cylinder. He had selected this type of casting because most of them had seen specimens of it, either inside or outside the foundry. Such cylinders were made up to 10 ft. diameter in one piece, and varied in length and thickness. They were often strengthened internally with additional flanges and ribs. He had purposely chosen a plain design in order to avoid complexity in description. (Articles on this subject by Mr. Smith have already appeared in our columns.)

There was little in common, said Mr. Smith, between sand and loam moulding, except that each method formed a mould that would hold molten iron and turn out a satisfactory casting. A loam moulder's daily routine was concerned with spindles, plates, bricks, straight-edges and square stricking-boards, strickles, etc.; whilst the sand moulder was concerned with various kinds of patterns—in some cases only pretensions to patterns—boxes, rammers, etc. When making a casting in loam, whether large or small, plain or difficult, the preparation of the tackle was most important, and if the casting was a difficult or intricate one there was the more reason for forethought, as it was at this point the ingenuity of the pattern-maker and moulder needed to be displayed. The work was laid out full size, as far as was necessary, in the pattern shop, and the moulder, with the aid of the pattern-maker, got the dimensions for his tackle from it. The important points for the moulder to watch in this matter, apart from correctness of sizes, were, first, that the tackle was strong enough; second, that provision was made for runner gates and risers, bolting up, and escape of air; third, provision for easing or liberating after pouring and for the contraction of the casting. Where more than one casting was required, the tackle when practicable should be so made that it would carry the work through. By consideration of these points, which often demanded much foresight on the part of both moulder and pattern maker, coupled with good methods of moulding, much time and expense could be saved. It was far preferable for a moulder, within reason, to err on the heavy, rather than on the light side, when making his tackle, because the breaking or snapping of a plate, binder, staple or bolt often meant commencing afresh, besides the possibility of injuries to those about the work.

All cake plates should be regularly prodded, and an abundance of vent holes cast in by means of pieces of core, coke, etc., but not to the extent that the plates would be unduly weakened or rendered liable to fracture when exposed to heat, as in drying after pouring, etc. The holes not only provided for the escape of air but also assisted in holding the loam to the plates. With regard to bricking and binding, the stability of loam moulds where much walling was required depended upon how the brickwork was done. Especially was this so where great length or depth of brickwork existed, either with moulds or with cores. He had seen moulds and cores collapse before stoving, simply from improper bricking. Other evil results, such as swells and irregularities, might be traced to faulty brickwork. The bricking should be done in such a manner that the bricks, as far as possible, would bind and support each other. As the brickwork was proceeding, each joint should be covered by the next course of bricks, and binders should be put on at intervals, these being necessary to support the brickwork and keep it intact during slinging, drying, etc. For instance, if a core or mould were 9 ft. to 12 ft. long, at least two or three binders should be used; they added stability and resisted deformation.

The loam for bricking should be neither stiff nor sloppy, but should be of a medium consistency with plenty of opening material, such as manure, shredded peat, long chaff, or chopped straw. The opening material not only assisted in bringing away the air, but also by its openness assisted in drying. If sloppy loam were used in bricking, the mould would assume any shape. If very stiff loam were used, the bricks would not bed aright; consequently, uneven walling would be the result.

Coming to the question of venting, the generation and expansion of gases during the pouring of the casting made it necessary for channels to be provided for their rapid escape. Various means were adopted to accomplish this. For example, where a flat or nearly flat surface formed part of the mould the bricks should be from ½ in. to 1 in. apart, with no loam between them, the open spaces being filled in with ashes or cinders to the level of the bricks. In all cases of bricking the allowance for loam between the brickwork and the striking board should be about ¾ in.; the opening material in the striking or finishing loam would then allow the air to pass through the cinders, and thus scabbing would be prevented. Escape through the cinders was also provided for by thin layers of straw laid on the bottom plate before the loam was put on for the first layer of bricks. Escape of air was also allowed for by holes in the bottom plate; and if that provision were not made, escape for the air could be provided for through the joints of the outside row of bricks—as was sometimes done when the brick mould was rammed with floor sand—by carrying around straw ropes which were finally brought off at intervals through other spaces. It did not matter what means were adopted, provided they were safe and the air could escape quickly enough to prevent scabbing and blowing. For conducting air from underneath the top or intermediate flange, or any narrow surface such as occurred in vertically-cast flanged cylinders, it was better to carry right around a narrow channel formed with stiff loam, filled with half-inch mesh cinders about 1 in. below the surface of the flange, finally bringing the gases off by wisps of straw or small ropes through the joints of the brickwork.

The next matter to be considered was the dressing, blacking, etc., of the mould and core. A large loam mould or core should not be checked for sizes when very hot. If dressed in that state and if, as probably would be the case, the pouring was not done till the moulds had become only warm, the sizes of the casting would not be accurate—unless the moulder was very fortunate in gauging how much the mould or core would contract between the time of checking the sizes and the time of pouring. If the mould or core was dressed and checked when very hot it would certainly be small when the casting came out. He was not referring at that point to the ordinary contraction of cast iron, allowance for which was always made in the size-sticks, but to the expanded state of large moulds or

* Before the Birmingham Branch of the British Foundrymen's Association, January 21, Mr. H. Pemberton in the chair.

cores when very hot, as bricks, loam barrels, binders, and plates all expanded with heat and contracted on cooling. It was also unwise to backwash a mould or core when very hot. The result of doing so often was that the loam cracked and web-markings were developed on the casting, though they had been quite invisible either on the moulds or on the core. This was quite apart from loam-cracks caused by the loam being too strong or too weak. Although the cause of this phenomenon was not quite clear, it appeared reasonable to suppose that when the blacking wash was applied to the hot loam, steam was generated and penetrated through the thickness of the loam to the brickwork or core barrel, and pushed the loam slightly away from the brickwork, thus leaving a small space between. No cracks would be visible in the loam, but when the casting was poured the pressure of the fluid iron forced the thickness of loam back against the brickwork, causing small, irregular markings which disfigured the casting when dressed off. This also occurred if the mould or core had had too keen a fire. In that case the bricks, barrel and loam expanded excessively, and during cooling the bricks and barrel contracted more than the loam, whilst the loam, on account of its arched shape, often retained the position resulting from the expansion. The cores and moulds when blacked should be just warm enough to dry the blacking.

The CHAIRMAN (Mr. H. Pemberton) said that Mr. Smith had shown them the necessity of a moulder being able to work from the drawing alone; he had also shown the necessity of making good, strong and safe tackle for the various kinds of work. He agreed with making the tackle, if anything, on the strong side, for avoidance of accidents was a most important consideration. With regard to key-ways in binders, the speaker remembered seeing some years ago a fluted column made in loam, the column being 22 or 23 ft. high and about 9 ft. in diameter. It had been bricked up with spacings about ¾ in. of loam between each brick to allow for contraction, but unfortunately this did not allow sufficiently for contraction, and when the contraction came on it burst the casting with a loud report, about a day and a half after casting. It was, of course, a very difficult job to make such a casting, but the second time it was made, in every course of bricks one was made of loam; these were easily chopped out, and this allowed the casting to contract, and the resulting casting was a good one.

MR. J. J. HOWELL (Smethwick) did not think too much stress could be laid on the importance of the safety of tackle. With reference to cracks, he would ask whether they were due to the hot fires put in to dry the mould. He thought some times they were due to the bricks, and certainly the bricks were more often blamed than the fire. Sometimes they had to use bricks which had been exposed to the weather and had not been allowed time to dry, and, as a rule, a very cheap class of bricks was supplied for loam moulding. The drying of the bricks was sufficient to drive the loam from the brickwork and thus cause contortions in the mould and misshapen castings. It appeared to him that the tackle described by Mr. Smith was unnecessarily elaborate, and that the key-way arrangement and so much splitting of the plates were an unnecessary precaution. Of course they ought not to take undue risks, but he thought that if the plates were cast in one piece with perhaps a 4 in. split in one section, or two nearly opposite each other, the keyway could be dispensed with. In his foundry they had to deal with jobs of less diameter than those Mr. Smith had described, and it would often be very difficult to get down the tackle to take out the key-bricks or key-plates. They used the loam brick, which was not necessary for them to get down at to destroy; the loam itself gave way. It appeared to him that loam moulding was very expensive, and he saw no reason why the job could not be made at much less cost in sand, in view of the expensive tackle.

MR. J. SHAW (Dudley) entirely disagreed with Mr. Howell as to making these castings in sand; he did not think they could be made in sand for 1¼ times the cost of loam moulding. With regard to Mr. Smith's tackle, he had seen the work done in other places without so much precaution. As to Mr. Howell's suggestion about the split plate, his own practice was to have keyways in the different binders, but they did not use loam bricks at all; they simply had what they called a thirling bar from top to bottom, and when this bar was drawn out relief was given all the way up. The wedge-shaped bar went right from the top to the bottom of the binders. As to several castings being made in one mould, some of them would remember that during the Manchester Convention some years ago they visited the foundry of Tweeddale & Smalley, Limited, where they were told eight castings were made in one mould. They actually saw a second casting made without a change of mould; the cylinder was drawn out, and, after the mould had been touched up a little, another casting was run in. These were not very strong castings; they were, he thought, about ¾ in. thick and about 3 ft. in diameter. They were for mill work that had to be turned up, and therefore it was necessary that they should be good castings. No doubt a mould often could be used again after re-blacking, but few of them were willing to take the risk. He had cast a 5-ft. cylinder similar to the one described by Mr. Smith, 1½ in. thick, in a mould which had been already used, but of course the core had to be rebuilt. With small cylinders of, say, 6 ft., he could not see any advantage in having a rotating core bar. In his own experience with cylinders 8 ft. in diameter and 7 ft. long, an iron casing was used, and the core was not bricked at all. These cylinders had external flanges, therefore only a straight core with a seating was needed. The cast-iron core casing was expanded by a wedge bar and placed and centred on a rotating cross similar to Mr. Smith's. There was a fixed striking board; and the whole was rotated by labourers stationed inside the casing. But for a cylinder of 6 ft. diameter, he would, from his own experience, prefer the core board to move. It often, however, occurred that one's men were used to one particular way of working, and if one introduced other methods that were equally good or even better, they might not, in those circumstances, prove to be cheaper.

MR. C. DONSON (Birmingham) thought the mould as shown could be made with tackle of considerable less cost, and in less time, and with equal security. The less tackle there was to fasten up, the less chance was there of mistakes in fastening up. The bottom or base plate should be cast in with the spindle in position with a tapered end to pass through the plate. For a very deep mould the top of the spindle could be stayed from the wall or pillar of the foundry. The procedure he recommended was as follows:—Sweep up and level the base plate, and build and sweep up the outside or cope with two rings, one top, and one bottom to carry the bricks, etc. When built up, cramp together as tight as possible. Having swept the cope, lift off on to a bogie and put into the stove to dry, then proceed with core on the same base plate, sweeping it up to where the flange and bracket require placing. (The flange being in three sections can be withdrawn with the brackets, when the core is swept up and set stiff.) Then proceed to build up the core to the height required, placing the top brackets in position and sweeping the top flange on, thus having the mould swept up except the top plate for the

runner or pouring well. The core being swept up on a bogie with a tier of loam bricks at each quarter is then run into the stove, and given its finishing coat, where it stands to dry, thus preventing any sagging or distortion, and avoiding internal plates, etc. When the mould is dressed and put together the top and bottom plates are cramped together securely and rammed (part way up and round the sides) to take up the extra strain at the bottom when casting. After a reasonable time for the casting to set, the cramps on the top and bottom plates are taken off; the cramps on the cope are left intact, and the mould tilted on to one side; then cut out one of the tiers of loam bricks to allow for contraction. Should the mould be of a light section, the other brick tiers could be cut out. This method would save a good deal of binding plates. The only part machined is the spindle with the tapered end. The centre is cast around the taper end of the spindle. It is policy to let the spindle be an inch or two through the bottom of the centre when there is a clear tapered hole right through.

Continuing, Mr. Dobson said that cylinders with external flanges required two or three copes according to number of flanges, and where situated. He generally made the plates in halves, with loops and bars, so as to avoid breaking them each time, and also put in a tier of loam bricks so that it could be eased between the flanges, and the plates taken off in halves.

Mr. I. Bullock (Birmingham) asked whether Mr. Smith found it better to mould the cylinders with the brackets loose and placed round the core, instead of making the brackets and internal flanges in a core box, and building same up in the main core top and bottom. In some foundries he found the moulders liked a good bevel on the back of the striking board and others only a little. What was Mr. Smith's opinion on this? From the slides shown it appeared that the tackle used was similar to that used when he was an apprentice; the core was taken round the board, instead of the board going round the core, and this method seemed to be considered as good to-day as it was then.

Mr. Poole considered that the tackle was one of the most important factors in loam moulding. A man that knew how to make his own tackle must have a general grasp of the details of the job, almost equal to a draughtsman or pattern-maker; if not they will always have to be at his beck and call. He did not think it necessary or convenient to go to the trouble of making the spindle described by Mr. Smith. In some instances it would be more practical to use an ordinary plate centre for the core and put the spindle in and secure by clamp board on top, make two sections of core instead of one and place on top of each other. In this case the core would be more rigid and not so likely to collapse in drying. The only trouble would be to get them in perfect line with each other. Mr. Smith had given a very lucid description of the method of making a plain cylinder, but what they rather want to know was how to proceed with a casting such as a large condenser with delicate parts, where it would be necessary to make both core and mould in at least two sections. Personally, he would like to see loam moulding more generally practised in Birmingham, but that did not seem very likely. With regard to the keys spoken of, a good number of men acquainted with loam moulding thought it was not practicable to have them, but he had seen keys put in 9-ft. jobs of considerable size. In that case all one had to do was to knock the key out. If the casting had been built up in the usual way of a continuous course of loam bricks, and it was necessary to release the core it would require a little perseverance and perspiration to accomplish the same end.

Mr. J. Matthews (Walsall) said that he had seen some of the jobs mentioned by Mr. Smith, and knew that to have dealt with them in any other way would have meant a great deal more expense than the cost of the extra strength of the tackle.

Mr. Buchanan said he recollected repetition castings of that kind being made many years ago by a firm in Glasgow. They used to have outside plates with short dabbers or prods on them. These were in segments, cut vertically, and were swept round and dried, there being no bricking whatever. That method was practised very largely by a large firm in Glasgow. When he was an apprentice, they used to use a rather soft brick, one reason being that it facilitated quicker working, because of the brick taking up the moisture from the loam and stiffening the loam quickly. They never dried the bricks first, but applied the loam and then gently stoved it after putting on the finishing coat, when, of course, they finished it and dried it thoroughly. He would like to ask Mr. Smith whether the bricks themselves allowed gases to pass through them; he was rather inclined to think they did, but he had no positive proof, and he could remember one instance where they did not. He saw a loam-moulder put a brick between two brackets with very little clearance between the brick and where the metal was to come. Although he was only an apprentice at the time, it did occur to him that the moulder was running a risk, and he said, "Don't you think that will scab?" The moulder replied, "Oh, no fear of that," but when the casting had been made there was a scab outside where the brick had been. With regard to casting two castings out of one mould, he had never done that. He had run metal twice into one mould, but he did not say that he had made two castings. (Laughter.) He had swept up a small loam mould and thought he would risk casting it on the floor, without any ramming up. He put small straps round it, but the metal unkindly ran out on to the floor. The mould was such a clean one, he thought it a pity not to use it, so he cast in it a second time, and successfully.

Mr. Smith, replying, referred to a remark by the Chairman about the brains in the foundry. He (Mr. Smith) thought that if brains were not needed in the foundry there was no department which required them. (Hear, hear.) With regard to Mr. Howell's question on the cracking of loam when exposed to damp bricks, he would say that he was never in favour of damp bricks. He believed in bricks being kept dry. A dry brick would stiffen the mould, because as soon as the loam was put against it the brick would begin to absorb the moisture, for a brick was like a sponge in that respect. But he did not think they would get air through the brick; he meant that they would not get metal to lie on the surface of an ordinary clay brick. Strange to say, the hardest bricks were the most porous, but, nevertheless, that was the fact. As to keyways and loam bricks, he dare not, with large castings, make the keys with loam bricks alone, though he knew a loam brick allowed contraction. He had made castings of a smaller diameter than those he had described, and fairly deep, with loam bricks in place of keys, but with fairly thin castings 7 ft. or 8 ft. in diameter and ¾ in. to ⅞ in. thick, the contraction was fairly rapid. The loam brick had its place and so had the straight bar, but the difficulty with a straight wedge bar was the internal flanges. As to Mr. Howell's suggestion that these castings could be made more cheaply in sand, to make and use a pattern of such a size would be an expensive and cumbersome job, and granting that

it would be a true job, which was doubtful, it would not be an economical one. Loam-moulding was looked upon as expensive, but for such jobs it was far cheaper than sand work. Take, for example, a cylinder of 7 ft. diameter and 7 ft. length; two men and an improver would make the casting in loam, mould and core in two days, and could do it every two days in the week, but a sand moulder would not do it in four days. With regard to repeating the casting in the same mould, he had visited places where they got more than one casting out of one mould, but he was never fortunate enough to be there when they were doing it. He did not think he could cast in one mould two castings such as he described; at all events, he would never venture to try. Besides, it took such a considerable time to prepare the mould for use again that it really would not pay to do it, especially when the question of safety and a clean casting was also taken into consideration. As to moving the core-board, having gone into many parts of England, Scotland and Wales, he found that everywhere each had its different methods of doing foundry work, and it was the most difficult thing in the world to get the men to depart from them; even if a man was convinced that there was a better method, he would not acknowledge it. For himself, when he saw another method that appeared better than his own he was ready to try it, and without trying to force it on the men, he was able to make them fall into it after a time. He had found the stationary vertical core-board a perfect success, and especially with brick cores of large diameter; the core was made as true as a die. The tackle was rather expensive, but for quite a big job one man could make all the tackle in two days, his time working out at 12s. or 14s. That was very little compared with the cost of making a pattern of the same size. He could not see how they were to dispense with key pieces; it would be more awkward to do what was required with loam bricks than with keys. The loam bricks had to be got out and that would be difficult with castings of that diameter. As to describing more elaborate work, he thought it better to give the A B C correctly than to attempt to compile the dictionary right away. The moulding of the more elaborate casting involved so many parts, and so many little operations, that it was difficult to give an intelligible description of such a piece of work. It was better to begin with something simple before going on to anything elaborate, and, therefore, he had taken the vertical moulding of a large casting. He might have taken a Corliss cylinder or some large hydraulic work, and have made a prettier picture, but it would not have been sufficiently clear for his purpose, as there were many things in these complicated cylinders which could not be put on paper in a way to make them intelligible. For vertical condensers they made the core right up from the bottom, and the method of providing for contraction was quite simple. With a moderate-sized casting the oar was put down and pulled out as the casting went on. But with a cylinder 7 ft. or 8 ft. in diameter it was not so easy, the amount of contraction was so great in cores of large diameter. As to the clearance of the strickling board, there was really not much in that either way.

Mr. Smith, continuing, again emphasised the importance of avoiding checking the mould when it was hot. It was surprising what a difference would be found in such a cylinder as he had described if checked when hot and afterwards when just blood-warm. Many a man had been led into a trap by using his size-stick when the mould was hot; after the mould had contracted the skin of the casting came out too small. These castings had to be made at a fairly good rate, it was a matter of casting every day, so that there was a temptation to check the moulds as quickly as possible. He had given prominence to the question of tackle because that was the chief thing in a loam moulder's work, but the loam moulder should have—and a good number of them had—ideas of drawings. The moulder could not go wrong with the pattern-maker by his side. The loam moulder was dependent upon the pattern-maker to a certain extent for certain explanations of the drawings, but the pattern-maker laid out the casting as far as possible to full size. The loam-moulder had nothing to work with but paper and his trammels for making his tackle, and, of course, he was better situated if he had some knowledge of drawing, in fact, he did acquire some knowledge of it in learning his trade, though of course, he did not need to be a draughtsman. He was inclined to disagree with Mr. Poole, who suggested that a loam moulder was superior in ability to a sand moulder. Once a loam moulder had got a thorough grip of his work, that work was far safer than that of a sand moulder. In loam moulding, as a rule, there was not one per cent. waste, simply because they had not the risks to run that a sand moulder had. Loam moulding, done under proper supervision, was as safe as any work could be, whilst the sand moulder had moisture and all sorts of things to contend with, such as the touching of a lifter, or a jerk of the box part, which often resulted in a waster, and the risks were a hundred to one as compared with loam moulding—he was not including pouring in short, or mistakes on the part of the draughtsman or the pattern-maker. With regard to striking the mould on a case without any brickwork at all, Mr. Smith said that he had been in a place where that was done regularly. They cast five big castings, each about 60 in. in diameter, every day with the loam simply struck on the cases. Three castings were poured in the morning. These were out at 11 o'clock, and two more moulds were then made in the same cases. These castings weighed about five tons each.

## Pitot Tubes for Gas Measurement.

Mr. W. C. Rowse, in a recent Paper before the American Society of Mechanical Engineers, gave details of a series of experiments made at the laboratories of the University of Wisconsin to obtain information concerning the reliability of the pitot tube as a means of measuring gases and to determine the accuracy of various forms of the instrument which are in common use. All tubes were compared with a Thomas electric gas-meter which was taken as a standard of measurement. Since any variation in results would be due to a wrong method of obtaining the static pressure, simultaneous readings were taken of velocity heads as shown by the pitot tube using the pitot static pressure and by the pitot dynamic tube and a piezometer. The pressure as obtained by the piezometer would not be affected by the form of tube used. The results may be summarised as follows:—(*a*) The pitot tube is a reliable means of measuring gases when the static pressure is obtained in a correct manner and when all readings are taken with a sufficient degree of refinement. (*b*) The piezometer is the most reliable means of obtaining the static pressure. (*c*) Of the various forms of static openings in the pitot tube itself, very small holes in a perfectly smooth surface give the most accurate results. (*d*) Slots give erroneous static pressures and beveled-end tubes for obtaining static pressures are not reliable. (*e*) The German Stauscheibe is a reliable means of measuring gases.

# The Use of Ferro-Alloys.

By Sidney G. Smith.

It has been suggested that the use of ferro-alloys in the iron foundry is in the nature of "doctoring" the iron. While this may be so, much depends upon the significance attached to the term doctoring. It certainly suggests weakness, and an attempt to cure. Now apply that suggestion to the steel foundry and steel makers generally. Will it hold good? The reply is it will not. It is demanded of the iron foundry at the present time that it shall produce castings, if possible, as durable as steel, and it is not considered that the steel foundry has the sole right to the use of ferro-alloys. Ferro-alloys are commercial products, and their use is open to all who can apply them with advantage; and if a cleaner, stronger, denser and more durable casting, with good machining qualities can with their aid be produced, that cannot be obtained otherwise, that alone justifies the iron foundry in their use. Their application, however, is not universal in iron founding, chiefly owing to the extra cost and the lack of knowledge of their judicious application. In the following comments the writer deals chiefly with personally-conducted experiments, so far as tests and appearances are concerned.

### Vanadium.

Ferro-vanadium is extolled as the master ferro-alloy. The writer made six comparative tests, 24 test bars in all, with transverse and tensile bars. Four transverse test bars, 3 ft. 6 in. by 2 in. by 1 in., were cast in each box. Two bars were first cast from the ladle, then ½ lb. of the alloy pulverised and containing 27.15 per cent. of metallic vanadium was added to the ladle, which contained 1 cwt. of iron, and the two remaining bars were poured. The tensile bars, which were equal to a 1-sq. in. when turned, were cast the same way. This plan ensured the conditions being the same with the bars that contained the alloy and those without. This is as fair a comparative test as can be made.

Summing up the results of the tests, both in transverse and tensile, the advantage was with the bars containing the alloy. The deflection average was the same in both the bars with and without the alloy. The difference in appearance of the iron in the molten state, with and without the alloy, was very marked, the iron containing the alloy giving rapidly moving small star designs. The difference in the appearance of the fractures was not so great to the naked eye. The bars containing the alloy were rather lighter in colour, perhaps finer in grain, and a little denser.

The pulverised alloy should be thoroughly stirred in very hot iron. It is preferable to put the desired amount of powdered alloy in the bottom of the ladle and tap the metal from the cupola on to it. The hotter the iron the more effective will the addition be. The following tests are from experiments conducted by Mr. Kent Smith in connection with vanadium in cast iron:—

*Tensile.*—A cylinder iron having a tensile strength of 26,000 lbs. per sq. in., by addition of 0.22 per cent. vanadium had its strength increased to 37,000 lbs. per sq. in.

*Transverse.*—A high grade air-furnace stock, which normally broke at the high load of 4,000 lbs., by the addition of 0.13 per cent. vanadium broke at 4,400 lbs.

*Compression.*—A sample of high-quality iron which resisted 135,000 lbs. per sq. in. compressed load before rupture had its compressive resistance raised to 150,000 lbs. as the result of addition of 0.18 per cent. vanadium.

*Hardness.*—Air-furnace iron which gave a Brinell hardness figure of 187 showed, as a result of the addition of 0.20 per cent. vanadium, a hardness figure of 196.

*Wearing Quality.*—A locomotive valve cylinder bushing of vanadium cast iron, which had been in exigent service for 22 months, on examination showed no signs whatever of abrasive wear, the original tool marks being still in evidence.

*Depth of Chill.*—It has been observed, as a result of close watching, that with an air-furnace iron containing approximately 0.9 to 1 per cent. silicon, 0.5 per cent. manganese, 0.04 per cent. phosphorus, 0.05 per cent. sulphur, 0.55 per cent. combined carbon, and 2.6 per cent. graphite, the addition of 0.22 per cent. of vanadium (resulting in the remaining in solution or combination of 0.16 per cent. vanadium in the iron) cause the chill to strike in a further 10 to 15 per cent.

*Shrinkage.*—Vanadium being allied in a somewhat modified form to the members of the aluminium family, naturally somewhat increases the shrinkage; but for all practical purposes this effect is so small that it may be neglected in the foundry. It has never been found necessary to change in any degree the pattern measurements on account of increased shrinkage caused by vanadium.

### Spiegeleisen.

Spiegeleisen when mixed with a silicious or weak, soft iron which is high in carbon gives most surprising results. It raises the transverse and tensile strength, entirely alters the grain, grade, fracture and appearance. When added in the right proportion it will change a No. 2 to a No. 4 fracture, giving a smooth, close and not too hard surface. Spiegeleisen contains up to 30 per cent. manganese, sulphur, and phosphorus being almost absent. The whole of carbon being combined, the iron is white. It can be added to the mixture in the cupola, or to the metal in ladle. When added to the ladle it should be broken up in pieces the size of a walnut, put in the bottom of the ladle, and the metal from the cupola alowed to run on to it. With a spiegeleisen containing 15 per cent. manganese, expressing the effect in a comparison in grade numbers, 20 lbs. to a ton of iron would change the fracture of a No. 2 to a No. 4. It is most useful in making close, dense and hard sections of iron which are very thick.

### Ferro-Manganese.

Ferro-manganese can be obtained with up to 90 per cent. manganese. It is useful in the iron foundry in several ways, and the experience of the writer is that with iron that is rich in carbon or silicon, or both, and low in manganese (which would be from a No. 1 to a No. 3) that the small additions of 1 lb. of alloy containing 50 per cent. manganese to 2 cwts. of such iron will give better results in transverse and tensile strength than the bars made of the iron untreated. Many other claims are made in its favour, such as inducing chill, etc., deoxidising and assisting in the partial elimination of sulphur. The

alloy should be pulverised and put in the bottom of the ladle, the same as ferro-vanadium.

### Ferro-Titanium.

The writer's experience with ferro-titanium is limited to a few comparative tests, and so far as the results of the tests went, there was some improvement in the iron containing the alloy. It may be stated that the iron to which the alloy was added was an excellent one, and as cast iron perhaps very little improvement was possible. The tests, therefore, do not indicate what benefit the alloy might be, when added to an inferior grade of iron. The fracture of the bars containing the alloy were slightly closer, finer, and lighter in colour. The transverse and tensile test results were also a little higher than in the iron not containing the alloy. The method of mixing the alloy was polling. Whether the wearing qualities would be improved, the writer is not in a position to say, but the claims are that the alloy improves the wearing part of a casting, induces chill, and combines with some of the occluded gases, assisting them to escape

### Ferro-Silicon.

Ferro-silicon is a softener, and is only of value as such in the iron foundry. It can be obtained containing upwards of 90 per cent. silicon. If softens the iron by promoting graphitic carbon, and may be useful for adding to hard iron. It is not easy to mix, and the best way to apply it is by polling. The writer has on numerous occasions used ferro-silicon successfully with iron that required softening.

### Application of Ferro-Alloys.

Regarding the above-mentioned additions, they can all, with only two exceptions, namely, vanadium and tianium, be obtained in the pig form. It may then be reasonably asked, why not, when the contents are known, mix the iron in that way? In answer, the writer would say he does not hold either form as being ideal. The excess of one particular constituent, either in the pig of richer forms of alloys, requires careful handling, and an approximate estimate of the results should be known by those who make the additions.

There are many cases in which the knowledge of handling rich alloys is useful. For instance, if the cupola is running on a No. 4 close iron, and a thin pulley weighing 6 cwts. is ready for pouring, this amount is too small for a special charge of soft iron; but a small percentage of ferro-silicon could be added to the ladle, giving the iron the desired softness for a casting of that kind. Or if the cupola is running on a No. 3, and a piece of gearing is ready for pouring, requiring a close, dense iron, a little rich ferro-manganese, or even some small pieces of spiegeleisen would bring that change about. In both cases no alteration is required in the charges of the cupola, which method is very often an uncertain proceeding. With ferro-alloys used in this way there may be a field worthy of consideration. It is advantageous to control the iron in the solid form by analysis, but it is also advantageous to control the iron in the molten form by the same means. Pig-iron can now be obtained to analysis and be mixed according to the requirements of certain work. Also there are brands of iron the approximate analyses of which are known; but possibly the physical properties are more important when mixing for particular work. In either case the object of a suitable mixture of iron is often attained.

The application of ferro-alloys is useful in the absence of large stocks of metal or in the event of temporary delay in supply, in which cases the elements in which the pig-iron is deficient can be supplied, or a constituent can be increased by the use of a ferro-alloy above the amount contained in the pig-iron. The writer is of the opinion that when ferro-alloys, their influence and methods of application are more widely known, the foundry store will be incomplete without its stock of such useful adjuncts; and although the foregoing remarks are brief and meagre, it is not because the writer's experience does not go further, but because the subject has been dealt with in a former article, in which the writer cited examples of the marked change in appearance in grain and fracture of foundry irons, as the result of personally-conducted experiments with ferro-alloys.

## Blast-Furnace Gas in the Foundry.

Discussing the application of clean blast-furnace gas, before the Cleveland Institution of Engineers, Mr. D. Neustadter said that the application of blast-furnace gas in foundries had received increased attention lately. Dr. Buck had written a treatise on the subject, in which he pointed out that its utility in this connection was accounted for by its very much lower contents of hydrogen and water as compared with coke-oven and producer gas. Experiments with coke-oven gas, and with mixtures of same, had shown that it was unsuitable for drying long vertical moulds, such as pipe moulds, on account of the water formed through combustion of the hydrogen being condensed on the upper colder portion of the moulds. The moulds were thus overheated and cracked in the lower portion, while the upper portion was not sufficiently dried. The same happened with certain kinds of producer gas which contained a large proportion of hydrogen. It was also pointed out that blast-furnace gas was preferable to producer gas for reasons of cleanliness. Producer gas deposited tar and soot, whereas clean blast-furnace gas left the pipes clean and burnt without residue. It was to this smokeless and odourless combustion of highly-cleaned blast-furnace gas that Dr. Buck attributed a large share in the increased producing capacities of modern pipe foundries. It permitted uninterrupted work on a revolving pipe-casting frame, and the casting of finished moulds while at the same time others were being dried, and even permitted the finishing of upper portion of moulds while the lower portion was already undergoing the drying process. The workmen were in no way harmed by the products of combustion.

Data as to savings effected by the use of blast-furnace gas in foundries were naturally difficult to obtain, but the author was able to give some figures collected at the Halbergerhütte. On account of alterations some time ago, four core ovens at these works, which were usually served by gas, had to be coal fired, which opportunity was used for making records. The coal used was of low grade, of an average calorific value of 7,260 B.T.U. per lb., and the four ovens were found to require 6,050 lbs. of coal per 24 hours' working. Records on the same ovens gas-fired showed a consumption of 187,000 to 260,000 cub. ft. of gas during the same period. Both systems, therefore, compared as follows:

Consumption when coal-fired = 6,050 × 7,260 = 43.8 million B.T.U.

Consumption when gas-fired = 223,500 × 107 = 24 million B.T.U.

Thus, with gas-firing only 55 per cent. of the heat was employed as against coal firing. With the use of the latest modern burners the gas consumption of these ovens had been further reduced.

# Moulding a Pipe for Turbine Connection.

By W. Needham.

The pipe in question was required to connect turbine and condenser, and was of a somewhat unusual shape, as shown in the sketch (Fig. 1); the base was

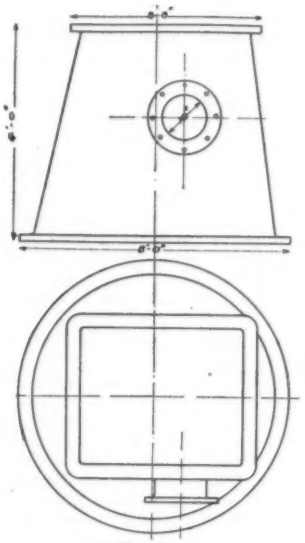


Fig 1.

circular and the head rectangular, with a branch in the side a little out of the centre. The only particulars with the order consisted of a template which gave no information as to the required shape between ends. To make a pattern for one pipe

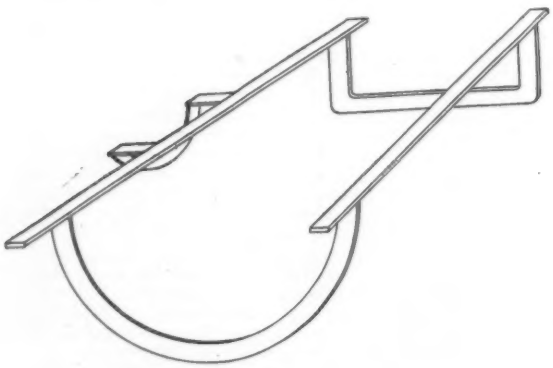


Fig. 2.

would be too expensive, and a loam block would take some days to prepare, but the methods outlined below are ready and effective.

The pipe may be moulded in the floor horizontally, and for this method the tackle (Figs 2, 3, 4, 5, 6, 7, and 8), would be required. The frame (Fig. 2) is laid on a level bed, sand being removed where necessary, and secured to wood plugs driven in flush. Strickle (Fig. 8) is used to sweep out the frame into a dummy for the core, and a $\frac{3}{4}$ in. layer of loam next laid on. Strickles (Figs. 3, 4, 5, 6) are for forming

Fig. 3.

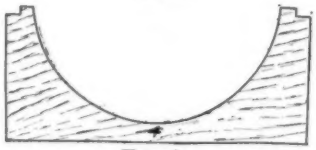


Fig. 4.

the core seats. The core iron is next laid in place, liftered where required and rammed up to the joint. On this is placed a layer of coke, and the ramming to the top completed. The layer of loam is now continued over the top half of the core and finished with strickle (Fig. 7), and the top box placed on and rammed up. After staking, this is removed, and the loam struck off the top of the core, which is then lifted out. The loam is next removed from the lower

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

half of mould, the mould skin-dried, fitted together, and is ready for pouring.

Another and better way is to mould the pipe vertically. The foundation plate is laid on a levelled bed after the spindle socket has been set in position, and the spindle and bed squared. The bottom

flange and a few inches of the core are swept (Fig. 9), which is all that can be done from the spindle, as the shape of the casting alters at this height. The bricks here are left open at the joint, and small

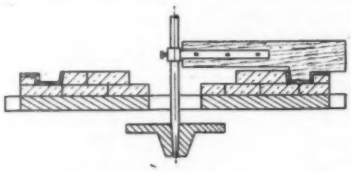


Fig. 9.

cinders inserted to prevent scabbing. The flange is first roughly struck, allowed to dry, and then finally struck. This is then dried, which process takes about three hours. A template, the shape of the body of pipe at the rectangular end, is then placed in position at the top end of core. This forms a guide to which the brickwork of the core is now carried.

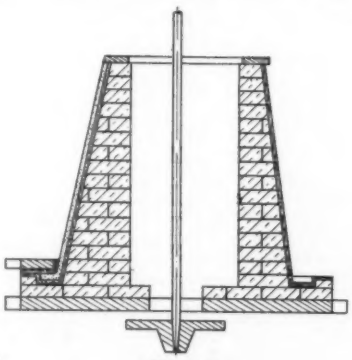


Fig. 10.

The core is then coated with loam and struck off with the strickle shown, by working the strickle on the template at top and round the flange at bottom (see right half of Fig. 10). Then a layer of loam being added and strickled again (see left-hand of Fig. 10), the core is made into a dummy for the mould, which is built up on the coping ring shown on the left, the dummy being coated with paper to assist parting when the mould is lifted off. When the mould is built sufficiently the branch is inserted.

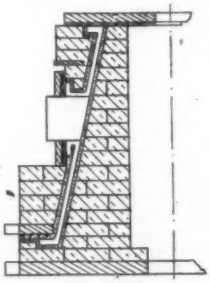


Fig. 11.

Fig. 12.

Template Fig. 12 is used to set the branch, fitting against the spindle and having a notch which is brought into position against a plumb line from the template at the top. The branch is bricked in position, left open at the face, which is covered with a loose plate, and the brickwork continued to the top (Fig. 11).

To form the top flange the pattern (Fig. 13) is placed level with the template on the core, and brickwork made up round. The top plate is struck with a plain striking board. The moulds are marked in several places, a weight of about half a ton placed on the core, and the mould lifted off, after the branch has been withdrawn. The paper is

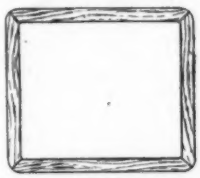


Fig. 13.

next removed and the core strickled down to size again. The moulds are then finished, blacked, and stoved, and when dried are then fitted together again and the top plate laid on. The branch is placed in position and a loose plate fixed against it. A core fixed through the print in the plate holds it central at the back end, and studs hold the front end.

About half an inch of metal should be allowed for facing the top flange, and one-eighth the bottom. The mould is then placed in the pit, a few pipes placed to carry off air and gases, rammed up, and is ready for casting.

## Resignation of Secretary of American Foundrymen's Association.

It is announced that Dr. Richard Moldenke, the well-known and popular Secretary of the American Foundrymen's Association, who for some time has been desirous of relinquishing the duties of that post, has now formally tendered his resignation. He will probably, however, not sever his official connection with the Association, as the committee have tendered the position of editorial and foreign secretary of the society, which, it is believed, he will accept. To fill Dr. Moldenke's unexpired term, an appointment shortly will be made by Mr. Alfred E. Howell, the President. During his term of office, Dr. Moldenke witnessed the growth of the American Foundrymen's Association from a small organisation with a small membership to an important technical society. Although probably best known as a metallurgist and an expert on malleable practice, Dr. Moldenke's investigations were directed into almost every branch of foundry work. He conducted important research work relating to cupola practice, particularly as affecting charging methods and economy in melting. He also conducted a series of tests on coke for metallurgical purposes, the conclusions from which threw new light on the foundry fuel problem. He has worked earnestly with the International and American Societies for Testing Materials, particularly on their committees on specifications for foundry pig-iron and castings, and has done much to aid the adoption of standards not only in the United States, but also abroad. Apart from his numerous contributions to technical journals and papers read before various societies, he has only one book to his credit, "The Production of Malleable Castings," though the result of a number of his investigations made on behalf of the United States Government under the auspices of the Bureau of Mines have been issued as bulletins. Dr. Moldenke will continue to devote his attention to the consulting work, the growth of which is the main cause of his discontinuance of the duties as secretary of the American Foundrymen's Association.

## Correspondence.

### Formula for Combined Carbon.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—Mr. Adamson, in his letter in your February issue, gives me credit for something to which I certainly have no claim, namely, the giving of a formula for the quantity of combined carbon to be found in a mixture. I did not at the Birmingham Branch, nor have I ever given any such formula; nor should I be so silly as to do so, seeing that the amount of combined carbon in a casting depends not only upon the silicon and carbon present, but also on the sulphur and manganese, and is also particularly affected by the rate of cooling.

I have looked through the report in your paper, and I certainly fail to find anything at all, stated or implied, that should lead Mr. Adamson to such a conclusion.

Yours, etc.,
F. J. COOK.

Smethwick, February 14, 1914.

### Moulding Sands.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—In your February issue, containing a report of the interesting discussion on "Moulding Sands," etc., opened by Mr. J. Shaw, at the Birmingham Branch of the British Foundrymen's Association, Mr. Heggie (President) is reported to have stated that "Empirical methods would continue for some time . . . and foundrymen would continue to judge by taking up a handful of sand, combining rule-of-thumb with a little scientific knowledge," referring presumably to methods of judging a moulding sand. With regard to this statement, may I be allowed to remark, that there is little necessity to resort to rule-of-thumb methods when testing a moulding sand, as it is quite possible to determine the physical qualities of such material sufficiently accurately as to anticipate its general behaviour in practice. I refer to methods of testing the physical qualities of such material under heat, etc., as advocated by myself in the columns of the FOUNDRY TRADES JOURNAL, and not chemical analysis, except when the sample contains 7 per cent. total impurities, in which latter case the material could not be termed commercially refractory. In support of the above statement I am prepared to diagnose any moulding sand of which Mr. Heggie may care to send me samples.

Mr. H. Winterton, at the same meeting, mentioned the great divergence of opinion prevalent in regard to the value of porosity. If Mr. Winterton were to grind up the finest moulding sand obtainable, to a powder, and attempt to cast grey iron with it, he will soon recognise the value of the property of porosity. A grey-iron casting of any weight made from such material would suffice to show the reasons for using a sand possessing a maximum porosity, consistent with strength or cohesiveness.

Mr. Parker mentioned that one large steel works imported sand from Belgium because it was superior to any obtainable in Great Britain; also he contended that such superiority was not due altogether to any geological cause, but was partly the result of extra care in mixing. Having tested a number of Belgian sands, not only in their raw state, but also in the form of facing mixtures, I can affirm that there are certain sands in Great Britain which possess equally fine qualities to those shown by the Belgian sands; also that the Belgian, like the British material, owes its good qualities to the particular geological stage of decay in which it exists, more than to the mixing (exclusive of working) to which it is subjected. The Belgian steel founder has a happy knack of recognising the value of isolated pockets in a sand formation, proving their value, then purchasing the complete bulk.

Yours, etc.,
ALGERNON LEWIN CURTIS.

Chatteris, R.S.O.
February 21, 1914.

### The Foundry and the Drawing Office.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—Your correspondent, Mr. D. Gordon, seems to ignore altogether the fact that there is such a branch of the moulder's art as loam work; here, in spite of accurately-made strickle boards and gauge sticks, a machine drawing is of inestimable value—at least I have always found it so; and this is especially the case in those foundries where the pattern-maker takes no part in the setting of the boards. Again, even where a full pattern and set of core boxes are provided, in a case of intricate cored work (for example, some designs of motor cylinders such as I have seen—four cylinders, with water-jacket, valve chambers and ports, all in *one* casting), what practical moulder will deny the value of a proper working drawing when assembling the cores, at all events for the first time, on a new job?

With regard to your correspondent's views as to the value of perspective drawings and sketches in the foundry, I have prepared "general arrangement" elevations of machinery on the geometrical perspective plan, as used by architects for elevations of buildings, etc., but have generally regarded these more as "pictures" for use of those unable to read a machine drawing, than as of any great value in the shops. For instance, what use would such a drawing be in either of the instances cited above? Surely very little, owing principally I think to the difficulty of intelligibly dimensioning such drawings; and then out comes the rule (unless its use is very strictly forbidden on all drawings, which is not the case in a great many shops), with disastrous results, as I have had cause to know.

No! On the whole I am not in favour of the perspective drawing for the foundry, whether it be prepared with the instruments or be only a "hand sketch;" in fact, of the two I would prefer the latter, as being least likely to deceive. I am fully in agreement with all you say in your article on page 13 of the January FOUNDRY TRADE JOURNAL. In fact, on reading it I considered it such a plain and sensible statement of facts as to need no comment.

Yours, etc.,
J. BLENCOWE HOWARD.

Edwardstone, Colchester,
February 18, 1914.

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—Will you permit me, as a designer and draughtsman, who has also a wide practical experience of engineering, including foundry work, to comment on this subject. Perspective drawing is the presentation of objects as they appear, mechanical drawing of objects as they are, and both require and presuppose an acquaintance with the principles of geometry. For the production of a correct perspective drawing, complete plan and elevation must be prepared, and the laws of optics applied in addition. So that perspective drawing, whatever may be its advantages, is at least not easier than the usual three-view presentation.

A competent mechanic of any trade should experience no difficulty in visualising a piece of mechan-

ism from plan, elevation and section, but the fact remains that we are constantly meeting mechanics who do experience this difficulty, and I have frequently to supplement a set of drawings with the "bit of a sketch" which Mr. Gordon mentions, and this occurs in nine cases out of ten with the pattern-maker. This is probably due to the fact that the machine shop receives its raw materials already somewhat shaped, while the pattern-maker has to realise the designer's intention fully before he can start. Now, should the pattern-maker be helped out in this way, or be left to his own resources? It is simpler to make him the perspective drawing in most cases than to write further instructions or to personally explain; but I find that the pattern-maker who requires this assistance usually presently makes some idiotic blunder which consigns something to the scrap-heap. In other words, he is not competent.

Whenever a perspective is supplied it is supplementary to the mechanical drawings, and to ask a works to turn out a job from a perspective only would be to ask for trouble, except the required article is of such simple shape that a drawing is scarcely necessary, for no amount of detail can be added with clearness and definition to such. A very brief examination of the working drawings of past generations will reveal the fact that the picture or perspective (more or less accurate) method of presentation is for older than the solid geometrical, which has superseded the former by reason of its greater exactitude, and I assert positively, that in the instance which Mr. Gordon cites—the steam engine—that a perspective would convey far less information and a less definite impression of the construction than would a plane general arrangement. Within my experience the sketch is only of use in giving a view of a bent part or curve which does not directly appear in plan or elevation, and I have never found it to be required in lieu of a general arrangement, but always to elucidate a detail.

A moulder should require no drawing to give him the over-all, or any other dimensions of the pattern with which he is supplied; he only requires the "bit of a sketch" when, as in the case of a complete casting, he works in direct collaboration with the pattern-maker, who has to see that all is clear before moulding commences, and as it is impossible for the designer to anticipate what part of his apparatus will present obscurities to the foundry floor, he leaves that for the pattern-maker to handle. In this case a knowledge of perspective is useful to the pattern-maker, but obviuosly if he has that knowledge, he is already acquainted with the geometric method of presentation, and to him a perspective would be superfluous.

The most important use of perspective is in the drawing office, when new designs are under consideration, for a rough freehand sketch in fair perspective is clearer than rough freehand plans and elevations; but always as soon as a design takes definite shape in the draughtsman's mind, he fixes it by the plane mechanical drawings, and this must be done before it can be examined critically, and at this stage the perspective is superseded.

There is no analogy between the use of perspective in engineering and in architecture, for the architect is greatly concerned with the effect of his art through the medium of vision, or the appearance he achieves; while the engineer is concerned almost solely with mechanical effectiveness, appearances being of little moment.

To sum up, while a draughtsman should always have perspective at his command for his own use, he should never be dependent upon it for conveying an idea; a pattern-maker should not expect it in his drawings, but should be capable of applying it with fair accuracy when occasion demands, and a moulder rarely requires any drawing, since most detail is settled for him by pattern.

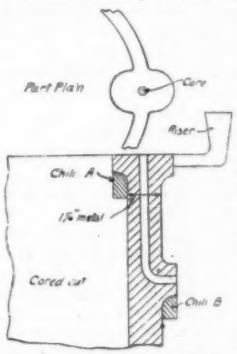
Yours, etc.,
A. NAPIER.

10, Broadway, E.C.

## Query.

### Trouble with Chills.

Can any of your readers explain a trouble that is being experienced with an iron chill used for chilling the inside corner of a lug, as shown in the accompanying sketch? The lower chill (B) gives no trouble and lasts for hundreds of castings, but the upper one (A) blows badly after being used about 6 times. The point is that both chills are cast with the same iron, the lower one gives no trouble at all, and the top one has to be renewed after every 6 castings, as it causes blowing. I can offer no explanation, except that oxidation of metal in the chill may occur and increase each time in use. The hot metal then may cause decomposition of the oxides with evolution of oxygen. The chills are used hot and coated with plumbago. This theory is, of course, upset by the quite correct behaviour of the lower chill. The moulds are dried and run in from the bottom.—"S. H."




### The Institute of Metals.

The annual general meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W., on Tuesday and Wednesday, March 17 and 18, 1914. The following is a list of the papers and reports that are expected to be submitted on the 18th:—(1) First report to the Beilby Research Committee, dealing with the solidification of metals from the liquid state, by C. H. Desch, Ph.D., D.Sc.; (2) "Bronze," by J. Dewrance; (3) "Vanadium in Brass; the Effect of Vanadium on the Constitution of Brass containing 50-60 per cent. of Copper," by R. J. Dunn, M.Sc., and O. F. Hudson, M.Sc.; (4) "The Quantitative Effect of Rapid Cooling on Binary Alloys" (second paper), by G. H. Gulliver, B.Sc.; (5) "Crystal Protomorphs and Amorphous Metal," by Professor A. K. Huntington, A.R.S.M.; (6) first report of the Nomenclature Committee; (7) "The Influence of Nickel on Some Copper-Aluminium Alloys," by Professor A. A. Read, M.Met., F.I.C., and R. H. Greaves, M.Sc.; (8) "Muntz Metal; the Correlation of Composition, Structure, Heat Treatment, and Mechanical Properties, etc., etc.," by J. E. Stead, D.Sc., D.Met., F.R.S., and H. G. A. Stedman, A.M.I.E.E.; (9) "The Micro-Chemistry of Corrosion," Part II., by S. Whyte, B.Sc., and C. H. Desch, Ph.D., D.Sc. The fifth annual dinner will be held at the Criterion Restaurant on March 17, under the chairmanship of Engineer Vice-Admiral Sir H. J. Oram, K.C.B., F.R.S. After the annual general meeting the next gathering of members will take place on May 12, when Professor E. Heyn, of Berlin, will deliver the fourth May lecture, his subject being "Internal Strains in Cold Wrought Metals, and Some Troubles Caused Thereby." The lecture will be given at 8 p.m. in the Hall of the Institution of Mechanical Engineers. The annual autumn meeting of the Institute will be held at Portsmouth during the second week in September, 1914.

# The Life of Crucible-Steel Furnaces.*

By J. H. Hall.

The recently announced run of three years, nine months and eleven days made by a crucible steel melting furnace of the Columbia Tool Steel Company, which is claimed as a world's record, brings forcibly to our attention the great improvements that have been made in the design, construction and operation of the Siemens regenerative crucible melting furnace since its introduction.

There are three factors that determine the life of a crucible furnace, or any other furnace for that matter :—Design, nature of refractories and conditions of operation (including the nature of the steel melted). To some extent these factors are interdependent. Thus, for instance, if a crucible furnace is to be operated single turn and allowed to cool off considerably at night, in order to save fuel, the use of clay-brick melting holes may be advisable, since silica brick is not well adapted to endure repeated heating and cooling. But the total life of a clay-brick melting hole is necessarily short. Again, if local conditions, such as danger of flood, made necessary the building of the furnace largely above ground, so that the radiation of heat is promoted, the cooling down of the furnace over the week ends, when no steel is melted, will be considerable—and the contraction of the furnace that results tends to rack it to pieces.

The character of the metal being melted affects the life of the furnace to a great extent. Low-carbon steel and steels made from iron and charcoal require higher temperatures and much longer melting time than high-carbon steel or steel made largely from scrap, and the life of the furnace will be shorter.

The figures available, showing the life of furnaces, are for this reason especially not strictly comparable, since the variations in the steel melted undoubtedly affect the life to a greater or less extent. Probably, however, the method of handling is as important a factor as the material melted, in determining the life of a furnace of given design and construction.

Originally the melting holes of the regenerative gas-fired crucible furnace were lined with first-quality firebricks. When the Siemens furnace was first introduced into the United States the life of a furnace was from four to six weeks; the short life was due in great part to lack of familiarity with the furnace on the part of the men in charge. As the workmen grew more skilled in handling the furnaces, this life was gradually increased to six months by re-topping, and in some cases to nine months or one year, by re-topping twice (by re-topping is meant rebuilding the upper portions of the melting holes).

A prominent manufacturer of refractory materials gives the following figures for the life of melting furnaces in several different shops with melting holes lined with first-quality firebrick.

| Plant. | Life of furnace in months. |
|---|---|
| 1 | 3 to 4 |
| 2 | 4 |
| 3 | 5 to 6 |
| 4 | 6 |
| 5 | 12 |

No details of design or nature of steel being made are given, but the average very short life of furnaces with clay-brick melting holes is quite evident. When the melting holes are lined with silica brick, the life of the furnace is greatly increased, as the figures in the following table show :—

| Plant. | Life of furnace. | | Heats. |
|---|---|---|---|
| | Months. | Days. | |
| A | 6–15 | | |
| B | 14–18.5 | | |
| B | 16 average | | |
| C | 18 | | |
| C | 19 | | |
| C | 15–21 | | |
| C | 18 average | | |
| D | 14 | | |
| D | 19 | | |
| D | 24 | | |
| E | 12 | 0 | 1 418 |
| E | 14 | 12 | 1,720 |
| | 16½ | 0 | 1 897 |
| E | 17 | 22 | 2,126* |
| E | 18 | 4 | 2,186 |
| F | 28 | — | — |
| F | 45 | — | — |
| G | 11 | — | — |

* Heats made as follows : Projectiles, 1,325 heats ; high-speed steel, 325 heats ; magnet steel, 250 heats ; chrome-vanadium steel, 40 heats ; nickel steel, 25 heats ; castings, 15 heats ; carbon steel, 70 heats ; miscellaneous, 75 heats ; total, 2,126 heats.

These figures are not improbably duplications in some cases. Compared with these records we have that of the Columbia Tool Steel Company, of a continuous run of 45 months and 11 days, for a total of 6,290 heats; the material melted is said to have been "high-grade high-carbon tool steel." The high-carbon steel, of course, does not require as high a heat as, for instance, cast steel of 0.25 per cent. C. or alloy steels (nickel or chrome-vanadium) of 0.30 per cent. C., but probably the reasons for long life of this furnace are good design, good refractories and careful handling.

There are several features of the design of this furnace that are worthy of notice. A strong foundation was provided to guard against settling and consequent racking of the furnace; the furnace was set with the working floor only about 31 in. above the ground level, so that the radiation of heat was minimised, tending to discourage contraction of the furnace and consequent racking of the brickwork; and the walls between the chequer chambers, which are frequently but 12 in. thick, were made 18 in. thick to insure against the leakage of gas into the air chambers and flues that commonly occurs when the furnace grows old. The holes were lined with silica brick of standard make; breast walls, flues between the chequer chambers and melting holes, chequers, etc., were of first-quality clay or firebrick.

* From a Paper read before the American Institute of Mining Engineers and printed in the "Transactions" of the Institute.

## Nitrogen in Iron.

According to a communication from Mr. W. Herwig, in "Stahl und Eisen," the gas contained in the blisters formed on steel plates during rolling and annealing has been found to consist chiefly of nitrogen. The gases evolved during the solidification of iron immediately after tapping from the blast furnace include large quantities of hydrogen and carbon-monoxide, white iron containing more hydrogen, and hot-blast grey iron more carbon monoxide. The nitrogen in steel turnings was reduced by heating in a current of hydrogen from 0.022 to 0.006 per cent., and, although it was not increased by heating in a current of nitrogen, yet from a mixture of nitrogen and hydrogen in equal proportions a steel was obtained, in one case, with as much as 0.052 per cent. nitrogen. The author considers that a similar action takes place in the converter. A steel containing 0.04 per cent. nitrogen, when tested, broke without elongation, but was improved by prolonged annealing.

# Foundry Plant and Equipment.

## The "Polygon" Hand Shaper.

A useful tool, put on the market by Messrs. Fish & Company, Polygon Works, Wellingborough, is illustrated herewith. Fig. 1 shows a type with 13-in. stroke, 10 in. cross motion of head, 12 in. by 9 in. table, 5¾ in. vertical movement of table, and 3 in. feed of tool block. The width of bed is 5¼ in., and the apparatus will cut a keyway in shafts up to 3 in. diameter. The head swivels to any angle and is graduated; the locking device is simple and efficient, all vees are accurately machined and hand-scraped, and are fitted with suitable keeps to take up wear.

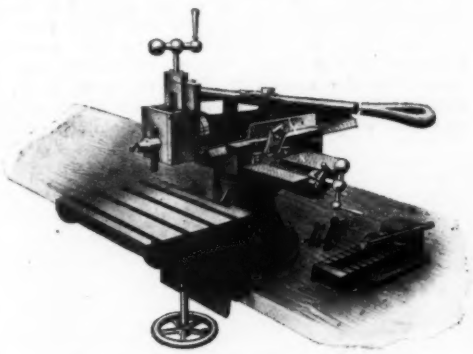


FIG. 1.—"POLYGON" HAND SHAPER.

The raising and lowering table can be quickly removed and long work such as columns and legs can be easily machined. The drilling attachment has two speeds and when not in use on the machine forms a most convenient portable drill; it is fitted with a ball-bearing thrust. The variable feed is obtained either by hand or automatically and is instantly reversible. The type of shaper shown in Fig. 2 is a portable tool free from complications, and will cut keyways in shafts up to 6 in. in diameter. The length of stroke is 13 in. and the cross motion of the

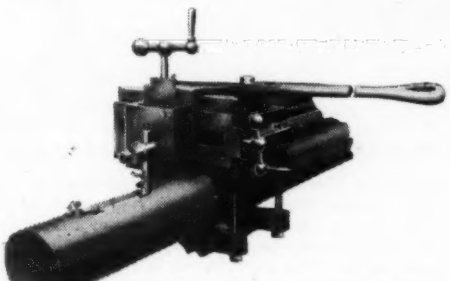
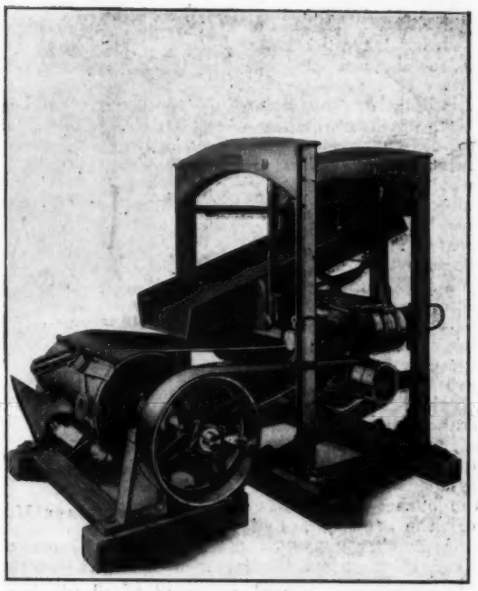


FIG. 2.—"POLYGON" PORTABLE HAND SHAPER.

head is 6 in. A useful feature of this type is that, being portable, it may be applied to the work where most convenient. It is thus not only a handy tool for the shop but is particularly useful for outdoor work. Any length of keyway may be cut without removing the tool from the shaft. The ram has great strength and is ribbed internally to withstand working strain. The tool box can be instantly detached by taking off one nut, and a drilling attachment supplied with the machine can be then clamped in its place. The latter is provided with two speeds: For drilling small holes the spindle is driven by a handle fitted on end of spindle; for drilling large holes the handle is fitted on to a short shaft set at right angles to the drill spindle, then the drill spindle is driven by a pair of bevel wheels, giving an increased purchase. This short shaft is carried in a bracket which can be swivelled about the centre of the drill spindle so as to bring it into a suitable position for turning the handle.

## Improved Magnetic Separator.

The magnetic separator, though a comparatively new departure, is sufficiently old to have thoroughly established its practical and commercial possibilities, and there can be no doubt that it pays the founder to call in its aid for treating moulders' sand and similar material. Picking and riddling are slow and anything but efficient methods of treating this material, for the recovery with such methods must be limited to the large brads, gaggers and more or less big lumps of metal; it is quite obvious that the small



MAGNETIC SEPARATOR FOR TREATING MOULDERS' SAND.

brads, wires, small shots and chippings from the fettling shops may easily get through the sieve. Moreover, in even a moderate-sized foundry the labour cost for picking and riddling is an item for consideration.

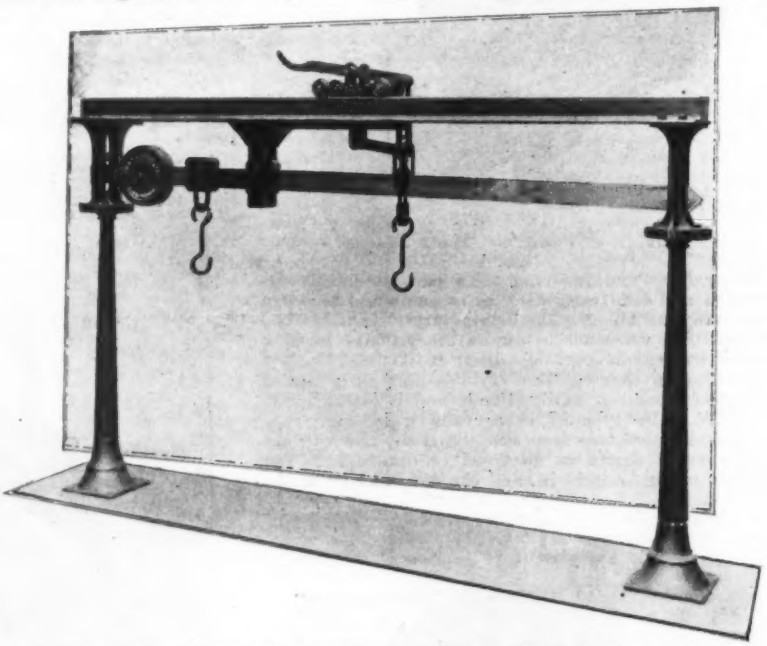
The saving in this last direction is graphically demonstrated in the machine illustrated, which is now installed in a large steel foundry, but which our representative saw on test at the works of the

makers—the Rapid Magnetting Machine Company, Limited, Birmingham. The installation of the machine has enabled the foundry in question to dispense with the work of two of the three men, who prior to the installation were employed in picking and riddling. One man is now fully occupied shovelling the material into the feed hopper of the machine, and there is a much larger recovery of metal.

The feed hopper is placed at the rear of the machine. From this hopper the material falls on to an inclined tray which oscillates laterally at 300 movements per minute. This causes the iron to sink by gravity and so find its way to the belt, and ensures the material being fed in a thin even stream, thus bringing the whole within the magnetic field. The sand is thrown off at the front of the machine and the metal is delivered into a hopper at the rear of and below the machine.

## Testing Mixtures Without Weighing.

Manufacturers are often impressed with the time occupied in weighing the different ingredients required in the constitution of their various articles of manufacture; and, what is of still more importance, the accuracy of the several weighings are liable to serious irregularities. These obvious requirements have induced Messrs. W. & T. Avery,, Limited, of the Soho Foundry, Birmingham, to design and manufacture a machine which claims to exactly meet the case. The machine, as illustrated herewith, will be seen to be of simple yet solid design. The steelyard is graduated in percentages to meet the wishes of the manufacturer, and buckets are hung from each of the hooks. As illustrating the operation of the machine, if a quantity of one ingredient is placed in the bucket on the left of the fulcrum, and the moving poise is placed on the 20 per cent. graduation, when the latter balances the steelyard the ingredients will be found to be in the proportion of 80 and 20. The steelyard can be marked in any desired manner to suit the requirements of any particular trade, effecting a great saving in time and ensuring accuracy. The machine can also be arranged to weigh the total of the mixture.



Percentage Measuring Machine, by Messrs. W. & T. Avery, Ltd.

## Process for Prevention of Corrosion.

Particulars of a new electrical process for the prevention of metal corrosion, recently introduced into this country from Australia, may prove of interest. Iron anodes, suitably insulated, are immersed in the water contained in the vessel to be protected, and a measured amount of electricity supplied to each. Each anode is controlled by a separate resistance coil, and is connected by wire to the positive pole of the source of electric supply, its affinity for acid and oxygen being increased or diminished according to the amount of current supplied. A direct-current low-tension (from 6 to 10 volts) rotary generator supplies the current, and is preferably driven by an electric motor. The vessel to be protected is connected to the negative pole of the source of the electric supply, and its affinity for hydrogen is controlled in accordance with the amount of current supplied. The current passes from the positive pole of the generator to the anodes, goes through the water, which is decomposed by the current, and enters the metal comprising the vessel to be protected, and returns thence to the negative pole of the generator. The action of the current is thus to attract the destructive oxygen and acids contained in the water to the anodes, and the protective hydrogen to the vessel. The acids and oxygen combine with the anodes to form oxide of iron; the destruction, therefore, or life of an anode depends upon its weight, also upon the amount of current consumed. The hydrogen that forms on the surface of the negative vessel not only protects it from corrosion, but the mechanical action of the hydrogen given off between the metal and the scale loosens and carries away into solution all dirt, scale or grease adhering thereto, and thus the troubles from corrosion and scale are overcome. If the vessel to be protected is already free from scale, the hydrogen given off all over its surface prevents any scale or solids from settling or adhering thereto, and also neutralises any corrosive effect of acids, oils, or free oxygen contained in the water. The process is applicable to boilers, condensers, pumps, feed-water heaters, etc., and is being put on the market by the Cumberland Syndicate, 44, Charing Cross, S.W.

# Inventions.

## Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

1,416. Core-drawing mechanism for use in casting metals. L. Ferman & Ferman & Company, Limited.

1,431.*Compressing or ramming the sand in flasks of moulding-machines. O. Eisele.

1,437.*Process for the electrolytic production of malleable or forgeable iron. E. F. K. Harbeck and B. Län.

2,033. Furnace tilting-gear for melting-furnaces for strip casting. Murphy, Stedman & Company, Limited, and H. A. Stedman.

2,034. Rotary table for strip moulds. Murphy, Stedman & Company, Limited, and H. A. Stedman.

## Abstracts of British Patent Specifications recently Accepted.

27,147 (1912). *Process for Manufacturing Steel or Iron.* G. Tischenko and H. Plauson, 23, Pessotschnaja oulitza, St. Petersburg, Russia.—The invention relates to the process in which carburisation of the molten charge is effected by means of gaseous or vaporised hydrocarbons sucked or forced through the liquid iron, and the process is carried out with electrolytically refined iron as the starting material. During the process the carbon in the hydrocarbons combines with the iron and produces iron or steel of any desired quality, depending on the duration and intensity of the treatment. The hydrogen liberated from the hydrocarbons may either take no part in the process or may act as a reducing agent on any final impurities in the mass, such as those traceable to the furnace material. It is important that the hydrocarbons employed should themselves be of a high degree of purity, and more especially free from thio-sulphates and compounds of phosphorus. Suitable compounds are for example the gases $CH_4$ and $C_2H_2$, and the vapours $C_6H_6$, $C_6H_{12}$, $C_{10}H_8$ and the like. The process is carried out in hermetically sealed furnaces and more particularly in electric furnaces, the carburising taking place preferably in a vacuum or under increased pressure. In order to obtain a steel of very high quality and dense structure it is advisable to carry out the carburisation first in a vacuum and then to continue the same under a pressure of from about 5 to 20 atmospheres.

1,166 (1913). *Manufacture of Metal Ingots.* L. E. Howard, Lockport, New York State, U.S.A.—This method involves pouring a mass of molten metal sufficient to form an ingot into an ingot mould, positioning the ingot whilst its interior is still fluid between dies forming part of the apparatus embodying the mould and capable of movement independently of the mould, and compressing the metal sufficiently to produce a kneading action. The machine for casting the metal ingots comprises a mould having movable lateral faces, a die having movable lateral faces located in substantially axial alignment with the mould, means for positioning a metal ingot cast in the mould between the faces of the die whilst in a partially cooled state, and means independent of the mould for applying pressure to the die.

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THE partnership heretofore subsisting between Messrs. G. C. Samuel and H. Astbury, carrying on business as mill furnishers and engineers' agents, at 52 and 53, International Exchange, Edmund Street, Birmingham, under the style of G. C. Samuel & Astbury, has been dissolved. The mill furnishing branch of the business will in future be carried on by G. C. Samuel, in partnership with others, under the style of Midland Mill Furnishers Company. The engineers' agency branch of the business will in future be carried on by H. Astbury.

# Trade Talk.

THE BRITISH MANNESMANN TUBE COMPANY, LIMITED, have taken temporary offices in King's Chambers, High Street, Newport.

THE EMPRESS WORKS, Johnstone, of Clifton & Baird, Limited, machine tool makers, etc., have been seriously damaged by fire.

MESSRS. CHARLES R. HONIBALL & COMPANY, engineers, have removed their business to 156-162, Boundary Street, Liverpool.

HICK, HARGREAVES & COMPANY, LIMITED, Soho Ironworks, Crook Street, Bolton, are giving up the manufacture of boilers.

MR. F. HUCKS, engineer, of Eastbourne, late of Hampstead Road, London, N.W., is paying a first and final dividend of 2s. 2d. in the £.

MESSRS. TAITE & CARLTON have removed from 63, Queen Victoria Street, London, E.C., to Sanctuary House, 33, Tothill Street, Westminster, S.W.

AT the meeting of the Leeds University Engineering Society, on February 9, Professor Goodman gave a lecture on "Engineering Problems in the Pyramids."

MR. W. N. KING, ironfounder, trading as the Northern Iron Works Company, Chilvers Coton, Nuneaton, is paying a first and final dividend of 2s. 10½d. in the £.

EXTENSIVE improvements are to be carried out at the Arbroath Works of the James Keith and Blackman Company, Limited, including a new machine shop, drawing office, etc.

OPERATIONS have ceased at the works of the Newport Rolling Mills, Limited, the site of the works having been acquired by Sir B. Samuelson & Company, Limited, the adjoining firm.

THE ACTIEN-GESELLSCHAFT FERRUM, Kattowitz, Silesia, have established a branch at 198, Winchester House, Old Broad Street, London, E.C., and will trade as Ferrum, Limited.

A MEETING of the Birmingham Section of the Institute of Metals was held on February 17, Professor Turner presiding. Mr. H. I. Coe read a paper on "The Production of Sound Copper Castings."

THE partnership heretofore subsisting between Messrs. J. Denham and H. V. Davies, carrying on business as engineers and contractors, at Newport, Mon., under the style of Joseph Denham, has been dissolved.

THE shareholders of the Cannley Foundry Company, Limited, have decided to wind up the company voluntarily, with Mr. J. P. W. Goodwin, Chancery Lane Station Chambers, Holborn, W.C., as liquidator.

MR. WILLIAM J. BROWN has opened an office at 44, Queen Anne's Chambers, Westminster, London, S.W., where he will represent the steel foundry and forge departments of the Skoda Works, Pilsen, Limited.

MESSRS. GEORGE ELLISON, engineers, etc., of the Victoria Works, Warstone Lane, Birmingham, have appointed Messrs. Nathan & Allen, Queen Anne's Chambers, Westminster, London, S.W., as their London agents.

THE discharge from bankruptcy of Mr. A. D. Furse, of the Southwark Engineering Works, Boundary Lane, Walworth, London, S.E., has been suspended for three years, the bankrupt to be discharged as from January 22, 1917.

THE partnership heretofore subsisting between Messrs. F. Thompson & H. Ochsenbein, carrying on business as electrical and mechanical engineers at 15 & 16, Garlick Hill, London, E.C., under the style of Thompson & Company, has been dissolved.

WE understand that Messrs. Campionne & Cie, Forges de Gueugnon, at Guegnon, France, have recently placed with Wellman, Seaver & Head, Limited, an order for two 30-ton fixed open-hearth furnaces of their latest design, with movable port ends.

THE partnership heretofore subsisting between Messrs. R. Duxbury, V. Sharples, and F. S. Cook, carrying on business as engineers and machinery and metal merchants, at Grimshaw Street, Preston, under the style of Duxbury & Sharples, has been dissolved.

ROBERT WARNER & COMPANY (ENGINEERS), LIMITED, Walton-on-the-Naze, Essex, have established a branch

at 25, Victoria Street, Westminster, London, S.W., which will be in charge of Mr. E. G. Wolfe Barry, the firm's agent in London, Liverpool and Belfast.

Messrs. B. Fiddian & Son, edge tool makers, of the Albion Works, 15, Brook Street, Stourbridge, have appointed Mr. J. M. Mitchell, 110, Cannon Street, London, E.C., and Mr. R. Schamberg, 45, Newhall Street, Birmingham, as their agents in London and Birmingham respectively.

Princeps & Company, engineers, of Sheffield, have been invited by the Secretary of the Board of Trade to place one of their patent "Little Scorcher" steam dryers in the Science Museum, South Kensington, in the permanent collection, as an example of the principle of abstracting moisture from steam.

It is officially announced that Marple & Gillott, Limited, iron, steel and machinery merchants, of Sheffield, have purchased from Sir Frank Brown, the liquidator, the Richmond Iron and Steel Company's Richmond Ironworks, Stockton-on-Tees. The restarting of the works at an early date is contemplated.

The partnership heretofore subsisting between Messrs. A. H. Horn & B. H. Pottier, carrying on business as engineers and machinists, at 25 and 27, Brearley Street, Birmingham, under the style of Horn, Pottier & Company, has been dissolved. Mr. B. H. Pottier will continue the business under the style of B. H. Pottier & Company.

The business of M'Culloch Brothers, engineers, 60, Elcho Street, Glasgow, carried on by Mr. James M'Mehen, has been transferred to Mr. James Wilson, engineer, 47, Glasford Street, Ibrox, Glasgow, who will continue it under the name of M'Culloch Brothers & Wilson. Mr. M'Mehen will discharge the liabilities of the old firm.

Messrs. Jacobs & Barringer, consulting engineers, 78, Gracechurch Street, London, E.C., have converted their business into a limited liability concern under the style of Jacobs & Barringer, Limited. Mr. T. W. Davis, Mr. E. A. Garratt, and Mr. K. A. Barringer, who have held important positions on the staff for a number of years, have been elected directors of the company.

The first meeting of the creditors of Mr. W. Merry, ironfounder (trading as John Northwood & Company), 227, Gooch Street, Birmingham, and 35a, Lower Essex Street, Birmingham, has been held at the offices of the Official Receiver (Mr. A. S. Cully). The liabilities expected to rank amount to £339, and there is a deficiency of £285. The case was a summary one, and was left in the hands of the Official Receiver.

The lecturer at the second meeting of the 34th session of the Nottingham Society of Engineers, held at the Welbeck Hotel, Nottingham, was Mr. J. T. Goodwin, of the Sheepbridge Coal and Iron Company, Limited, who took for his subject "The Microscopical Examination of Metals." Mr. J. Crawford, the president, occupied the chair, and supporting him was Professor C. H. Bulleid, of the Nottingham University College Engineering Department.

Extensions in progress at the Prescot Works of the British Insulated & Helsby Cables, Limited, include the erection of an iron foundry for the production of castings to meet the company's requirements, which hitherto have been bought from outside, an additional cotton-covering shop and a water tower, of ferro-concrete construction, of a capacity of 65,000 gallons. This will supply the whole of the works, the water being pumped from wells in the neighbourhood.

The annual dinner of the Birmingham Association of Mechanical Engineers was held at Birmingham, on February 14, Mr. A. H. Horne Morton presiding. A number of the relics of James Watt were on view. These have been presented to the city, and pending the arrangements by the City Council for their reception, they are housed at the Cornwall Works. Those present included Mr. E. C. R. Marks, Major-General Keir, Mr. D. T. Young, Lieutenant-Colonel E. Martineau, and Mr. B. Alfred Raworth.

Under the compulsory winding-up order made against L. Faulkner & Sons, Limited, ironfounders and engineers, 34 and 36, Gresham Street, E.C., on October 14 last, the official receiver has issued a summary of the company's statement of affairs showing a deficiency of £1,685, as regards creditors, and of £8,030 as regards shareholders, making a total deficiency of £9,715. The directors account for this deficiency as to £7,818 by depreciation in the value of the company's property. As a result of the statutory meetings of creditors and shareholders the Court, on January 13 last, decided that the official receiver should continue to act as liquidator.

Prospectuses have now been issued by the Museums and Art Galleries Department of the Corporation of Glasgow for the special loan exhibition of engineering models, appliances, and apparatus which is being organised by the department. The exhibition is to consist of memorials of eminent engineers and inventors, with models, drawings, and other illustrations of their inventions and discoveries; appliances, tools, and drawings relating to general mechanical engineering, railway and automobile engineering, marine engineering, electrical engineering, etc. The exhibition, which will be held in the Kelvingrove Museum, will be opened in May and will continue open for six months.

The sixth annual dinner of the University of Birmingham Metallurgical Society has been held at the White Horse Hotel, Birmingham, the president, Professor Turner, being in the chair. Sir Hugh Bell, Bart., was the principal guest. The chairman, introducing Sir Hugh Bell, mentioned that their distinguished visitor had every year for the past eight years permitted one of their students to spend some time in his works. Sir Hugh Bell, proposing the toast of "The University," said he had often looked with admiration to the work done in Birminhgam. The remaining toasts were "The Society," proposed by Mr. H. Silvester, responded to by Mr. O. W. Ellis, and "Past Students and Friends," responded to by Mr. H. Fowler.

The members of the Cleveland Institution of Engineers held an enjoyable conversazione on February 23 in the hall of the Cleveland Literary and Philosophical Society, Middlesbrough. Mr. Edward Crowe, the president, presided over a large gathering. An interesting illustrated address on "The Structure and Properties of Some Brasses" was given by Dr. J. E. Stead, F.R.S., who, together with Mr. H. G. A. Stedman, of Middlesbrough, is to give a paper on the same subject at the Institute of Metals in London next month. Some instructive exhibits were sent by Messrs. MacLay, H. G. A. Stedman, C. A. Parsons & Company, Limited, the Cambridge Scientific Instrument Company, Davy Brothers, Limited, H. M. Taylor, and the British Westinghouse Electric and Manufacturing Company, Limited.

A meeting of employers, convened by the Employers' Parliamentary Council, has been held in London, when a resolution was unanimously carried calling upon the Government, in view of the continued and growing menace to personal freedom, public order, and industrial peace, due to the provisions of the Trade Disputes Act, to set up an enquiry into the working and effects of the Act, and to determine whether certain amendments in regard to picketing, etc., should not be made. The chairman (Sir Richard Temple) said the fact that it was possible for labour unions to engage in an organisation or conspiracy against the whole of the community by holding up the means of communication and transit showed they were not living in a properly-governed country.

The Council of the Manchester University has appointed Mr. Charles Alfred Edwards, D.Sc., to the Chair of Metallurgy and Metallography in the University for the term of three years. Dr. Edwards acted as assistant in the Metallurgical Department in the National Physical Laboratory under Dr. Carpenter before the latter was appointed Professor of Metallurgy at the Manchester University, and subsequently was appointed Research Assistant to Professor Carpenter at Manchester, and was elected to a Carnegie Research Scholarship. It is proposed that the work of metallurgy shall be divided between the Departments in the Faculties of Science and Technology respectively by assigning the study of physical metallurgy, including metallography, to the laboratories situated in the old College Buildings, and chemical metallurgy, including assaying and fuel, to the labora-

tories situated in the Municipal School of Technology. The title of Mr. E. L. Rhead, M.Sc.Tech., the present Lecturer in Metallurgy in the School of Technology, will be lecturer in metallurgy and assaying.

For the purpose of inaugurating a section of the Junior Institution of Engineers, with Sheffield as its centre, a meeting was held in the Cutlers' Hall, Sheffield, on February 21. The chair was occupied by Mr. E. King, chairman of the Institution. The chairman, after explaining the object of the meeting, pointed out that the formation of a local branch would be very beneficial to young engineers in Sheffield and district. The Institution was not antagonistic to any other existing society or institution. The main idea was to help young engineers. It did not confine its members to Britishers, being cosmopolitan in every way. Mr. W. J. Tennant gave a short account of the history of the Institution, after which it was decided to form the branch, and the following committee was elected pro tem:—Messrs. J. A. Little (general manager, Cammell, Laird's Grimesthorpe Works); Thomas Firth (managing director, Messrs. Firth); F. W. Mellowes (managing director, F. Mellowes & Company, Sheffield); J. R. Williams (superintendent, Sheffield Corporation Power Station); and R. J. Stanley (manager of Sheffield Labour Exchange). Mr. R. J. Stanley was appointed secretary, pro tem.

An interesting experiment was made at a meeting of the members of the Coventry Engineering Society on Friday, February 6, when a paper was read by Mr. W. H. Thomas, entitled "A Visit to a Sheffield Steel Works," the cinematograph being used for the purpose of illustrating the lecture. The works described were those of Wm. Jessop & Sons, Limited, Brightside Works, Sheffield, and by means of the films the members were able to see the operations carried out in the manufacture of high-speed steel and castings. Owing to the smoky conditions which prevail in the works a large amount of artificial lighting had to be employed by the cinematograph firms to enable the films to be taken, but they were eminently successful throughout the series of nine reels in securing splendid definition, and the various movements could be followed with ease throughout. The films were only finished during the week previous to the meeting at Coventry, this being the first time they had been publicly screened, but Messrs. Jessop have undoubtedly secured a record which has a high educative value, and opens out a new and useful sphere for the moving picture. In addition to the films, the 60 lantern slides which originally accompanied the paper were also shown. For the purpose of the meeting the Society had specially engaged one of the city's film theatres, and in the unavoidable absence of Mr. Thomas the paper was read by Mr. E. F. Maitland.

Mr. John Burns, the new President of the Board of Trade, was the guest of the Manchester Engineer Employers' Association at their annual dinner on February 13 last. He was congratulated by the chairman, Dr. Edward Hopkinson, upon his appointment to the Presidency of the Board of Trade, and in his speech he said that he hoped to be a "practical idealist" in his new office, having regard for the hopes of life as well as for the facts of trade, and dealing with all industries impartially. "My position," he continued, "enables me to say a few words about your trade. I have had the honour of taking a census—it only comes once in ten years, and it is a fortunate coincidence that an engineer happened to conduct the last. In the course of that census, I have been able to gather a few interesting facts about your trade in Lancashire. In these days when the wave of self-depreciation that intermittently comes over Britons has not exhausted itself, when we are apt to say that things are worse than they used to be and they are going to be worse than they are now, Lancashire men may correct the pessimism of their Jeremiahs by a few solid facts about themselves. In 1851 Lancashire had 47,100 persons engaged in general engineering and machine making, of whom 600 were women. In 1911 it had more than 181,000, of whom 6,000 were women, a total increase of 285 per cent. in the number of persons employed in the engineering trade. No trade can show a greater increase, no country in the world can show such a wonderful ratio of progress as these figures reveal. Going from Lancashire to England and Wales, I find that in 1851 there were 370,000 male persons engaged in the engineering trades and 32,000 females. In 1911 there were 1,114,000 males and 82,700 females, an increase of 800,000. These figures indicate no evidence of decline in men, no decay in the women, and no collapse of that great engineering trade of which Manchester is the recognised centre. It is a marvel of growth, organisation, prosperity, and endurance of which Lancashire and Manchester have every reason to be proud. It is due in many ways less to yourselves than some of you think in your proud moments; it is due not only to the skill and capacity of this generation, but also in no small measure to the inherited mechanical genius and the transmitted sense of power and pride of industry that is a big characteristic of Lancashire, Yorkshire, and of Scottish industrial people."

The businesses of W. & T. Avery, Limited, and Henry Pooley & Son, Limited, have been amalgamated. Subject to approval by the shareholders as a whole, the directors of Henry Poolev & Son, Limited, have approved of the terms of an agreement for the sale of the company's business as from September 30, 1913, to W. & T. Avery, Limited. The basis of the agreement is as follows:—"The preference shareholders of Henry Pooley & Son, Limited, who hold 13,000 5½ per cent. cumulative preference shares of £5 each, will receive 65,000 5½ per cent. cumulative B preference shares of £1 each in W. & T. Avery, Limited, credited as fully paid. That is to say, the holder of one £5 5½ per cent. cumulative preference share of Henry Pooley & Son, Limited, will receive 5½ per cent. B cumulative preference shares of £1 each, fully paid, in W. & T. Avery, Limited, ranking for dividend from September 30 last, up to which date dividend on the preference shares in the company has been paid. The ordinary shareholders in Henry Poolev & Son, Limited, who hold 73,670 shares of £1 each, will receive a dividend at the rate of 6 per cent. per annum for the period from January 1 to September 30, 1913, and also 36,835 fully-paid ordinary shares of £1 each in W. & T. Avery, Limited. That is to say, the holder of two £1 ordinary shares in Henry Pooley & Son, Limited, will receive one fully-paid ordinary share of W. & T. Avery, Limited, ranking for one-half of the ordinary dividend on the ordinary shares of W. & T. Avery, Limited, for the financial year ending March 31, 1914. A reorganisation and increase of the share capital of W. & T. Avery, Limited, to £600,000 will be carried out as follows:—(*a*) The existing 30,000 ordinary shares of £5 each of W. & T. Avery, Limited, will be sub-divided into 150,000 ordinary shares of £1 each, and £150,000 new ordinary shares of £1 each will be created, ranking pari passu in all respects with the before-mentioned sub-divided ordinary shares. (*b*) 150,000 5½ per cent. cumulative B preference shares of £1 each will be created ranking for dividend, and on a winding up, after all the rights of the existing first preference shares of W. & T. Avery, Limited. The share capital of W. & T. Avery, Limited, will thus be increased to £600,000, divided into:—30,000 5 per cent. first cumulative preference shares of £5, £150,000; 150,000 5½ per cent. B cumulative preference shares of £1, £150,000; 300,000 ordinary shares of £1 each, £300,000, of which there will be issued, after providing for the purchase of Henry Pooley & Son, Limited, 24,967 £5 first preference shares, £124,835; 65,000 £1 B preference shares, £65,000; 143,460 £1 ordinary shares, £143,460; total, £333,295. In order to preserve continuity, it is intended to transfer the assets and business of Henry Pooley & Son, Limited, other than freeholds, leaseholds, and fixed plant and machinery, immediately upon completion to a new company to be registered with the same name, the whole of the share capital of which company will be held by W. & T. Avery, Limited, or their nominees. Sir J. Fortescue Flannery and Mr. Lawrence Jacob will join the board of W. & T. Avery, Limited, and the whole of the directors of Henry Pooley & Son, Limited, will act as directors of the new company of Henry Pooley & Son, Limited."

## Deaths.

THE death has occurred of Mr. R. H. Boyd, a director of J. & T. Boyd, Limited, Shettleston Ironworks, Shettleston, near Glasgow.

MR. R. HARWOOD, at one time director of Hick, Hargreaves & Company, Limited, Soho Ironworks, Crook Street, Bolton, has died at the age of 79 years.

MR. A. T. GREEN, proprietor of the business of A. T. Green & Sons, of the Northfield Engineering Works, Rotherham, died recently at the age of 71 years.

THE death is announced from Madrid of the Marquis de Urquija, who took an active part in the development of the iron and steel industries in the North of Spain.

MR. F. BRITTAIN, proprietor of the business of S. S. Brittain & Company, crucible steel makers, of the St. George's Works, Lead Mill Field, Sheffield, has died at the age of 78 years, after nearly 50 years continuous connection with the iron and steel industries of the district.

THE death is announced from Annecy, France, at the age of 76 years, of M. Georges Paccard, a well-known French bell founder. One of his most notable productions was the monumental bell at the Cathedral of Sacré Coeur, at Montmartre, Paris, known as the "Savoyarde."

THE death is reported of Mr. W. Keighley, of Powell Street, Scott Park, Burnley, at the age of 46 years. He was a son of the late Mr. George Keighley, founder of the firm of George Keighley, Limited, Bankhouse Ironworks. Mr. William Keighley was formerly a member of the firm, but retired from it some years ago.

THE death has taken place of Mr. J. Evans, the works manager of the Dowlais works of Guest, Keen & Nettlefolds, Limited. The deceased gentleman was the son of Mr. William Evans, J.P., Brynteg, Merthyr, general manager of Messrs. Guest, Keen & Nettlefolds. Mr. J. Evans was only thirty-seven years of age. He was educated at Shrewsbury School, after which he was entered as an apprentice at the Cyfarthfa Works. His first move was to Barrow-in-Furness, where he was in the blast furnace department. Leaving Barrow, he became blast furnace manager at Cyfarthfa. Messrs. Guest, Keen & Nettlefolds later on acquired the Cyfarthfa Works, and Mr. John Evans was appointed works manager at Dowlais. Mr. Evans was well known throughout the trade, and was a member of the Institute of Civil Engineers and the Iron and Steel Institute.

THE death has occurred of Mr. John Burnett, chief labour correspondent to the Board of Trade. The deceased was born in 1842, and at the age of 12 he left Alnwick for Newcastle, where he was in the care of his uncle, and served his apprenticeship as an engineer. Later he was employed at works on Tyneside, including Armstrong's at Elswick and Palmer's at Jarrow. He came into prominence in 1871 when he led the movement in Newcastle for a nine hours' working day in the engineering trade, achieved after a lengthened strike. Mr. Burnett was the first Labour leader to enter official life in England. When in 1886 Mr. Bradlaugh succeeded in persuading the Government of the necessity of establishing a Labour Bureau, Mr. Burnett was appointed correspondent. The Government five years later appointed him a member of the Royal Commission on Labour, and in 1893, when a Labour Department of the Board of Trade was established, he became Chief Labour correspondent.

LORD WIMBORNE died on February 22 at Canford Manor, Dorset, after a long illness. Ivor Bertie Guest, first Baron Wimborne, was the eldest son of Sir Josiah John Guest, and was born on August 29, 1835. He succeeded his father as second baronet in 1852, and was raised to the peerage in 1880. His family owed its wealth and progress to industrial enterprise. His great-grandfather was John Guest, who migrated from Broseley, Salop, about the year 1750, and, settling at Dowlais, Glamorganshire, established extensive ironworks, known as the Dowlais Iron Company and Guest & Company. In later years the Patent Nut and Bolt Company, Limited, Nettlefolds, Limited, and Crawshay Bros. (Cyfarthfa), Limited, were absorbed, and the combined concerns, with the exception of the latter, became known as Guest, Keen & Nettlefolds, Limited. The Guest family, however, gradually dissociated themselves from the management, and the name is now the only link between the Guests and one of the oldest and largest iron and steel works in the Principality.

## Personal.

MR. G. A. FISH, of Messrs. James Maude & Company, Sherwood Foundry, Mansfield, Notts., has been made a J.P. for Mansfield.

THE late Mr. L. Reid, lately works manager of the Barrowfield Ironworks, Glasgow, left personal estate in the United Kingdom valued at £2,068.

THE gross value of the estate of the late Mr. J. Llewellin, formerly associated with Llewellins & James, Limited, engineers, of Bristol, is £38,617.

MR. F. H. BARNSLEY has resigned his position as chief engineer to Cammell, Laird & Company, Limited, which position he has held for the last six years.

THE gross value of the estate of the late Mr. G. H. Lloyd, a director of the Weldless Steel Tube Company, Limited, is £14,998, of which £14,824 is net personalty.

THE late Mr. William Martin, of the Dundyvan Iron and Steel Works, Coatbridge, left personal estate of the total value of £78,524, of which £77,630 is in the United Kingdom.

THE late Mr. T. Martin, chairman of the Charlestown Foundry and Ironworks Company, Limited, Charlestown, St. Austell, left estate of the value of £63,545 gross and £60,919 net.

MR. J. G. WALKER, a director of Henry Walker & Son, Limited, of the Gallowgate Ironworks, Gallowgate, Newcastle-on-Tyne, has been added to the Commission of the Peace for Newcastle.

THE late Mr. J. W. Williams, of Philip Williams & Sons, iron masters, Wednesbury Oak, Tipton, left estate of the gross value of £136,545, of which the net personalty is sworn at £128,403.

SIR PERCY GIROUARD, D. S. O., a director of Sir W. G. Armstrong, Whitworth & Company, Limited, has been elected a member of the North-East Coast Institution of Engineers and Shipbuilders.

MR. T. R. THOMAS HEYWOOD, who has been appointed locomotive superintendent of the Great North of Scotland Railway, is at present assistant locomotive superintendent of the Taff Vale Railway.

ADMIRAL H.S.H. PRINCE LOUIS OF BATTENBERG, First Sea Lord of the Admiralty, has accepted the invitation of the Committee to open the Shipping, Engineering and Machinery Exhibition, at Olympia, London, W., on September 25 next.

MR. T. ROLAND WOLLASTON, M.I.Mech.E., consulting engineer, of Lord's Chambers, 26, Corporation Street, Manchester, has resigned the position he has held during the last seven years as North-Western representative of the Power-Gas Corporation, Limited, of Stockton-on-Tees.

MR. W. HANNING, a leading representative of the British engineering profession in France, has been re-elected president of the British Chamber of Commerce, Paris, after a successful term of office. The engineering and metallurgical section is well represented on the Chamber's board, for Mr. Charles T. Hounsfield, well known in the Sheffield steel industry, has also been elected vice-president.

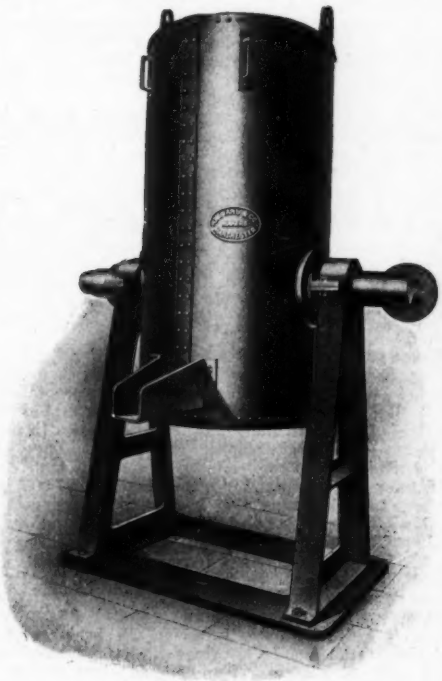
MR. DAVID MOWAT, Summerlee Iron Works, Coatbridge; Mr. John Symington, tube manufacturer, Airdrie; Mr. John Frood, ironmaster, Hayfield, Motherwell; Mr. Findlay Ross, manager, Tube Works, Coatbridge; Mr. Herbert Beard, Gartcosh Steel Works, Chryston; Mr. Archibald Watson, engineer, Mossend; Mr. Alexander Brander Allan, Clyde Wire Rope Works, Farme Cross; Mr. Robert Rankine, engineer, Fereneze, Dumbreck, Govan; Mr. Matthew Lang Simpson, Steel Company of Scotland, Limited, Newton; and Mr. Robert Highgate, engineer, Wellshot Road, Shettleston, have been appointed Justices of the Peace for Lanarkshire.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.

# THE Cupola.
# Evans's Rapid.

**Foundries Completely Furnished.**

## EVANS'S NEW CUPOLETTE
**For Emergency Work.**



**James Evans & Co.,**
Britannia Works,
*Blackfriars,*
*MANCHESTER.*

Telegrams: "LADLES, MANCHESTER."

## New Companies.

Deep-water Engineering Company, Limited.—Capital £3,000 in 1s. shares.

Stanley G. Flagg & Company (England), Limited.—Capital £2,000 in £1 shares, to carry on the business of engineers.

Grierson Brothers, Limited.—Capital £10,000 in £1 shares, to carry on the business of ironfounders, etc. Registered office: Ashton-under-Lyne.

Caxton Engineering Company, Limited.—Capital £1,000 in £1 shares (900 pref.). Registered office: Caxton House, Tothill Street, Westminster, London, S.W.

James Hall & Sons, Limited.—Capital £7,000 in £1 shares, to take over the business of engineers and ironfounders carried on by J. Hall and F. Hall, at Blue Boar Foundry, Rochester, as James Hall & Sons.

George Plumpton, Limited.—Capital £10,000 in £1 shares, to carry on the business of tool and file manufacturers. The first directors are G. Plumpton, S. Plumpton, and P. Hodson. Registered office: Albion Works, Leicester Street, Warrington.

Deeley Development Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of developing engineering inventions, etc. The first directors are J. S. Harrison and W. Blouet. Registered office:—28a, Basinghall Street, London, E.C.

W. T. Bowie & Company, Limited.—Capital £10,000 in £1 shares (8,500 preference), to acquire and carry on the business of W. T. Bowie & Company, Glasgow, manufacturers of wire ropes, engineers and founders, etc. The first directors are W. T. Bowie and W. E. P. Bowie.

Edward Holme & Company, Limited.—Capital £10,000 in £1 shares, to take over the business of engineers carried on by E. M. Holme and P. Schofield at the Textile Works, 347, Chester Road, Manchester, as Edward Holme & Company. Registered office: Textile Works, Chester Road, Manchester.

Birks & Lockwood, Limited.—Capital £4,000 in £1 shares, to carry on the business of manufacturers, importers and exporters of and dealers in iron, steel and alloys. The first directors are S. F. Birks and W. Lockwood (both permanent, subject to holding £1,000 shares). Registered office: 34, Edward Street, Sheffield.

H. & W. Munslow, Limited.—Capital £10,000 in 9,975 ordinary shares of £1 each and 500 employés shares of 1s. each, to take over the business of a brassfounder carried on by H. Munslow at Ellis Street, Birmingham, as H. & W. Munslow. Mr. H. Munslow is the first director. Registered office: 41 and 42, Ellis Street, Birmingham.

Bangham & Brooke, Limited.—Capital £3,000 in £1 shares, to carry on the business of dealers in metal and scrap, founders, etc., and to adopt an agreement between E. B. Bangham and E. H. Brooke. The first directors are Mrs. E. B. Bangham and E. H. Brooke (both permanent). Registered office: Temple Buildings, Goat Street, Swansea.

Hadley Brothers, Limited.—Capital £7,000 in £1 shares, to take over the business of engineers and machine tool makers carried on by Joseph Hadley, John Hadley, T. Hadley, W. F. Hadley, and J. B. Shepherd, at 32-35, Great Hampton Street, and at 53, Tower Street, Birmingham, as Hadley Bros. and the Premier Screw Company respectively.

Rogers & Forster, Limited.—Capital £5,000 in £1 shares (500 founders') to carry on the business of iron and tinplate makers and workers, and to adopt an agreement with J. Forster. The first directors are W. W. Hackett, C. T. Barlow, H. Rogers (chairman), and J. Forster (managing director). Registered office: Paddock Works, Oldbury.

Samuel Butler & Company, Limited.—Capital £25,000 in £1 shares (12,500 preference), to take over the business of engineers and steel and iron founders, bridge builders and contractors, carried on at Albion Works, Stanningley, near Leeds, as Samuel Butler & Company, and to adopt an agreement with I. G. Butler. The first directors are I. G. Butler (permanent) and E. H. Firth.

T. H. White (Devizes), Limited.—Capital £7,000 in £1 shares (3,500 preference), to carry on the business of heating, lighting, sanitary and general engineers, etc., and to acquire the business carried on by the executors of the late T. H. White at Devizes, Wilts. The first directors are Mrs. E. White and G. W. Frowd (both permanent), and one other to be appointed by Mrs. White.

Peckett & Sons, Limited.—Capital £80,000 in £1 shares, to take over the business of locomotive builders and engineers formerly carried on by G. T. Peckett, T. Peckett, and L. Peckett, as Peckett & Sons, at the Atlas Locomotive Works, St. George, Bristol. The first directors are:—G. T. Peckett, T. Peckett, and L. Peckett. Registered office: Atlas Locomotive Works, St. George, Bristol.

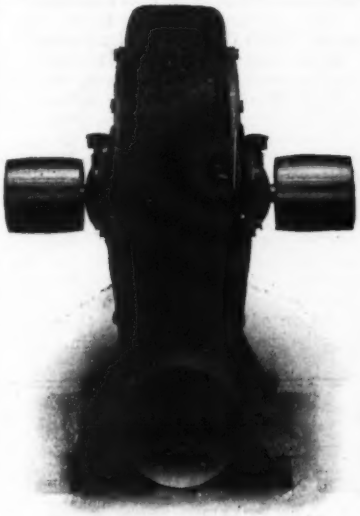
Barker, Harrison & Sons, Limited.—Capital £3,000 in £1 shares, to take over the business of brassfounders, bedstead mount and fender manufacturers, etc., carried on at Progress Works, Camden Street, Birmingham, as Barker Harrison & Sons. The first directors are B. Harrison (managing director), A. Harrison, H. Harrison, and R. B. Harrison. Registered office: Progress Works, Camden Street, Birmingham.

David Rowell & Company, Limited.—Capital £15,000 in £1 shares (5,000 preference), to take over the business of a constructional engineer, fencing merchant and manufacturer of iron buildings and general export and import merchant, carried on by J. B. Rowell as David Rowell & Company. The first directors are J. B. Rowell (permanent governing director) and W. T. E. Barker. Registered office: 33, Old Queen Street, Westminster, London, S.W.

British Aeromin, Limited.—Capital £150,000 in £1 shares (75,000 seven per cent. cumulative and participating preference), to carry on the business of mechanical, electrical and general engineers, metallurgists, smelters and refiners of ores and metals, proprietors of ore reduction works, rolling-mills and all kinds of machinery for the working of metals, wire drawers, millwrights, smiths, ironmasters, steel makers, founders, etc., and to adopt an agreement with the Aerometal Syndicate, Limited. The first directors (to number not less than two nor more than seven) are G. D. Mackay and G. W. Sessions. The Aerometal Syndicate, Limited, or any of its members while holding 30,000 shares have the right to nominate two directors or one director while holding 15,000 shares.

### Refractory Materials.

According to Mr. Ambrose N. Diehl, of the Carnegie Steel Company, the ideal refractory material for the iron and steel industries should possess the following qualities:—(1) Ability to prevent heat losses through radiation: (2) ability to withstand the heat impressed on it without altering its chemical or physical relations; (3) sufficient hardness to prevent abrasion and yet not spall; (4) low expansion and contraction; (5) inertness to chemical reactions taking place within its confines. "Up to the present time,' remarks Mr. Diehl, "we have not found the material which will meet perfectly all this specification. One class of refractories will satisfy certain of the above requirements, but will fail in others. We must, therefore, select for our various processes that material which possesses the most of the desired factors, and gracefully overlook the qualities which are lacking. That we are doing this is shown by the selection of different proportions of clays for the various demands in blast-furnace requirements, and the combination of the silica roof and basic bottom with a neutral zone in open-hearth practice. . . . Our (Duquesne) material expense for open-hearth renewals during the first six months of the year 1913 amounted to approximately £30,000, of which 78.30 per cent. was expended for refractories. The cost of the material used in the last six blast-furnace linings approximated £35,000, of which 66.08 per cent. was expended for refractories."



TRADE SIROCCO MARK

# CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

*Write for Bulletin No. 2028F.*

## DAVIDSON & CO., LIMITED,

**Sirocco Engineering Works,**

**BELFAST.**

# ELDERS FOUNDRY COKE

**AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.**

**The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.**

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

## Elders Collieries, Ltd., Cardiff.

## PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

| METALS. | End Feb., 1914. | End Feb, 1913. |
|---|---|---|
| IRON—Scotch pig warrants ton | .... *56/6 | .... *67/7½ |
| —Middlesbro' warrants ton | .... 50/7 | .... 61/5½ |
| —W.C. M/nos Bessemer ton | .... 66/0 | .... 86/0 |
| —Stock, Middlesbrough tons | .... 134,421 | .... 224,940 |
| COPPER—Chili bars GMB ton | .... £64 7 6 | .... £65 5 0 |
| —Stock, Europe and afloat tons | .... 27,653 | .... 44,673 |
| TIN—English ingots.. ton | .... £175 0 0 | .... £233 0 0 |
| —Straits .. .. ton | .... £174 10 0 | .... £215 15 0 |
| —Stock, London, Holland U.S.A., and afloat.. tons | .... 18,703 | .... 13,348 |
| LEAD—English pig .. ton | .... £20 0 0 | .... £16 15 0 |
| SPELTER—Ord. Silesian ton | .... £21 10 0 | .... £25 0 0 |
| QUICKSILVER (75lb.).. bottle | .... £7 10 0 | .... £7 15 0 |
| ANTIMONY—Regulus ton | £27 10 0 £29 10 0 | £36 0 0 £37 0 0 |
| ALUMINIUM—Ingot .. ton | .... £86 0 0 | .... £88 0 0 |

* Settlement price.

### CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

| | £ s. d. | £ s. d. |
|---|---|---|
| Columns (plain).. .. .. .. | 7 7 6 | to 7 12 6 |
| Pipes, 1½ to 2½ in. .. .. .. | 6 5 0 | to 6 10 0 |
| ,, 3 to 4 in. .. .. .. | 5 17 6 | to 6 0 0 |
| ,, 5 to 8 in. .. .. .. | 5 12 6 | to 5 15 0 |
| ,, 10 to 16 in. .. .. .. | 5 15 0 | to — |
| ,, 18 to 24 in. .. .. .. | 5 15 0 | to — |
| Chairs .. .. .. .. | 4 5 0 | to 4 6 0 |
| Floor plates (open sand) .. .. | 3 10 0 | to 3 12 6 |

### SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows : Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 10s. 0d.; all per ton, f.o.b. London. Copper (clean), £58 10s. 0d.; brass (clean) £40 0s. 0d.; lead (usual draft), £17 17s. 6d.; zinc, £16 0s. 0d.; all per ton delivered merchant's yards.

### Silicon Castings.

While it is known that pure silicon possesses remarkable acid-resisting properties, no use has been made of the metal hitherto because it was not available in commercial quantities. The Carborundum Company, Niagara Falls (U.S.A.), has now succeeded in producing silicon metal in large quantities, and has reduced the cost of manufacture to such an extent as to give it a permanent place among the baser metals. To reduce the silicon from the silica sand, large electric furnaces are employed, into which a mixture of coke and pure silica sand is charged. At the high temperatures obtainable in these furnaces the reduction of the silica occurs, and silicon is produced, varying in purity from 90 to 98 per cent. The physical properties of cast silicon are:—Density, 2.5—2.6; melting point, 1,430 deg. Cent.; boiling point, 2,800 deg. Cent. (calculated); hardness, 6 on Mohs scale; its tensile strength is approximately 1,000 pounds per square inch, and it is the least compressible of any metal. Silicon is used in the form of pipes for the conveyance of acid gases at high temperatures from stills to condensers, also in the construction of the condensing batteries themselves, and proves much more efficient than stoneware. Silicon pipes also are used for the transportation of hot, liquid sulphuric and nitric acids. For lining purposes this metal is used in centrifugal pumps, acid valves and pipes for the elevation of corrosive liquids by compressed air. Castings are preferably made at least ½ in. in thickness, with the exception of pipes less than 2 ins. in diameter, which can be made with a ⅜ or ¼ in. wall.


BLOFIL
THE
IRON CEMENT
(Quick or slow setting grades)
IS
THE CHEAPEST
AND
MOST RELIABLE
for all purposes.
*Unaffected by oil, steam, or water.*

Sole manufacturers—

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(DEPT I)
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HULL
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GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
*Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.*
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

*Established 1863.*

# JAS. DURRANS & SONS,

## Phœnix Works, Penistone, Near Sheffield

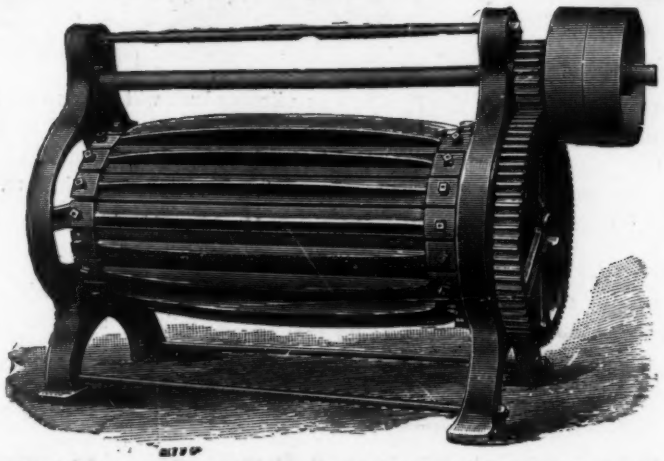
**Manufacturers of all**

## *FOUNDRY EQUIPMENTS*

**COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST**

**Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.**

## Improved Foundry Rattler or Fettling Drum.



**These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.**

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

# MACHINE MOULDED CASTINGS.

Do any of these castings interest you? Drop us a line and we will tell you the type of machine and the number of boxes put down per day of any of the castings shewn. In addition to these we have made machines and patterns for hundreds of other castings and will be pleased to send information as to the best machine for your requirements on receipt of particulars.

Our range of Hand, Hydraulic, Pneumatic and Electric Moulding Machines cover the requirements of any foundry.

It will cost you a penny stamp only to post your enquiry, the result will probably mean a saving of hundreds of pounds, less anxiety through 1914 and a better balance sheet in 1915.

**SAND BLAST PLANTS. SAND PREPARING MACHINES. CORE MAKING MACHINES.**
**Call and see them at work.**

## THE LONDON EMERY WORKS Co., PARK WORKS,
**TOTTENHAM. LONDON. N.**

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*Addresses and further information will be found by reference to the Firm's Advertisement.*

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Thwaites Bros., Ltd.
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Kühule, Kopp & Kausch.
London Emery Works Co.

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Thwaites Bros., Ltd.

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Marshall & Co., Horace P.
Tilghman's Patent Sand Blast Co., Ltd.

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Evans, J., & Co.

**Crucible Furnaces (Lift-out).**
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Evans, J., & Co.
Phillips, J. W. & C. J.

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Murphy, Stedman & Co., Ltd
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Davis, T., & Sons.
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Davidson & Co., Ltd.
Davies, T., & Son.
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London Emery Works Co
Olsen, Wm.
Simm, M. & Sons.
Walker, I. & I.
Wilkinson, Thos , & Co , Ltd.

**Foundry Brushes.**
Durrans, J., & Sons.
Evans, J., & Co.
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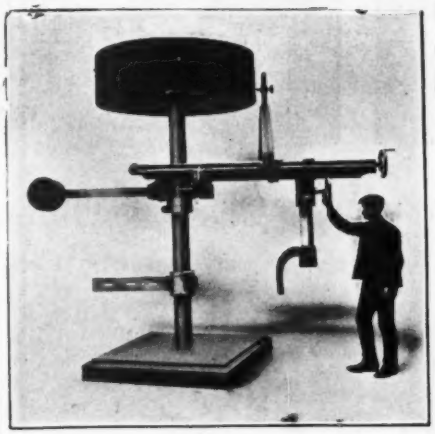

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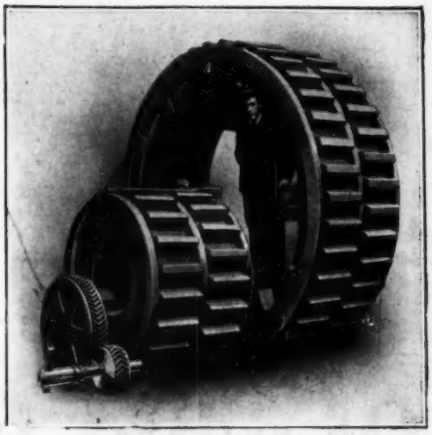

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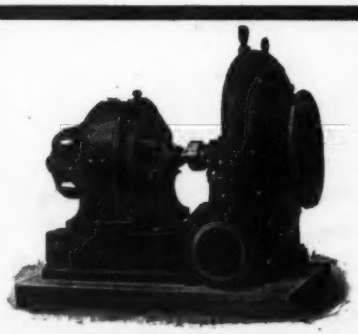

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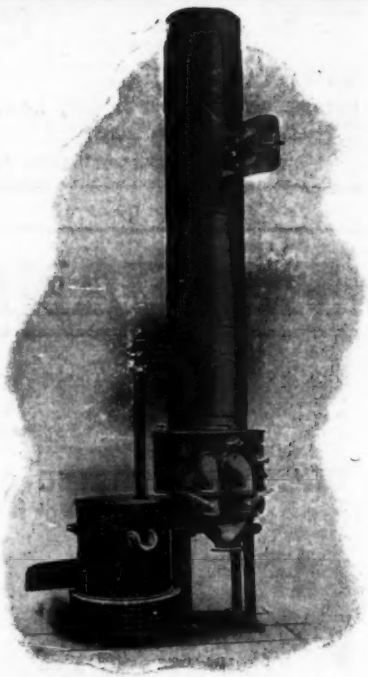

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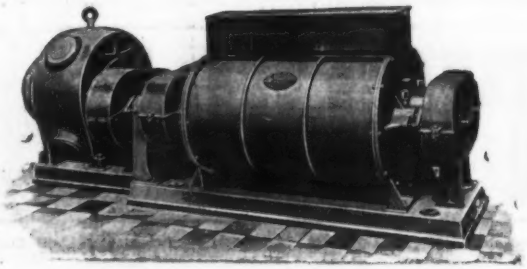

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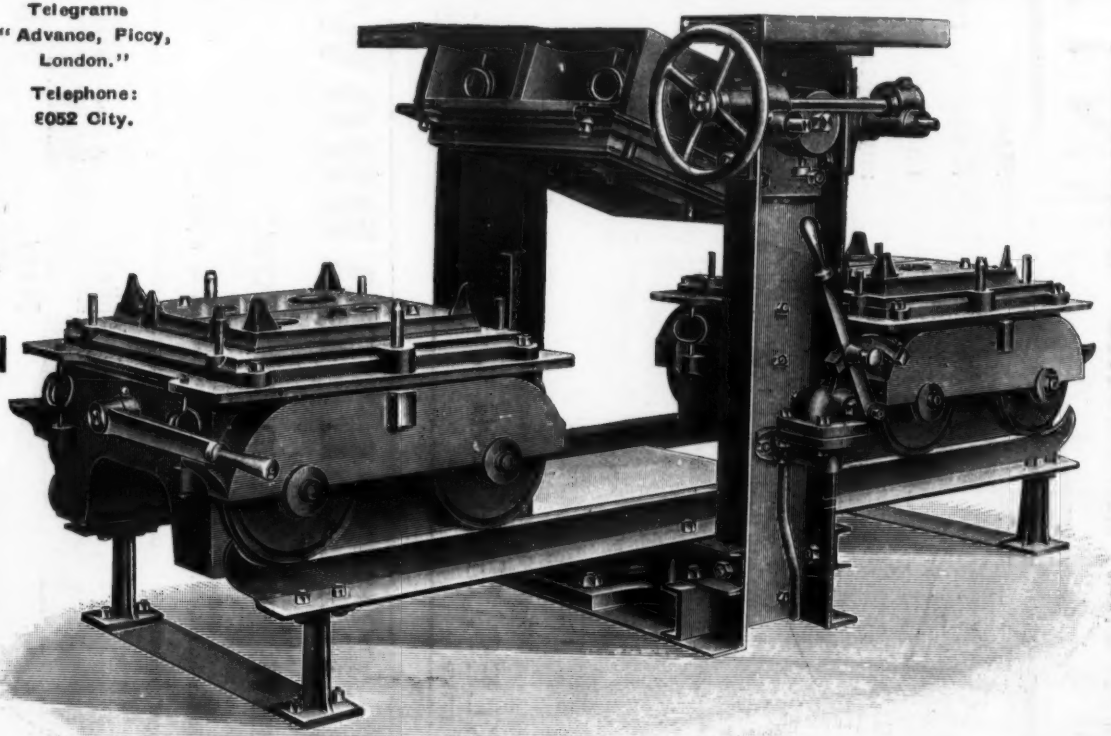

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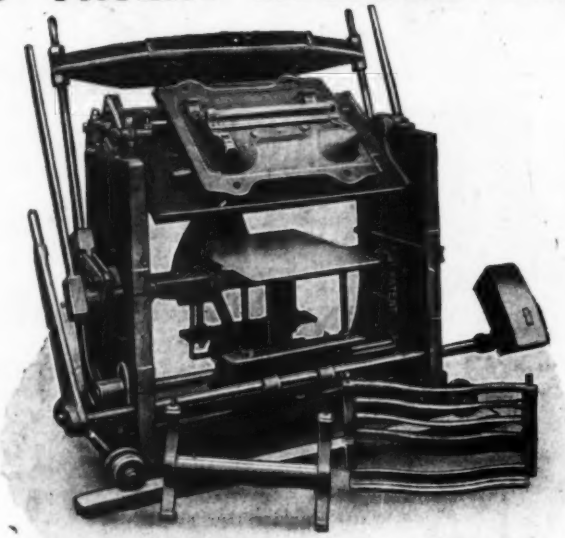

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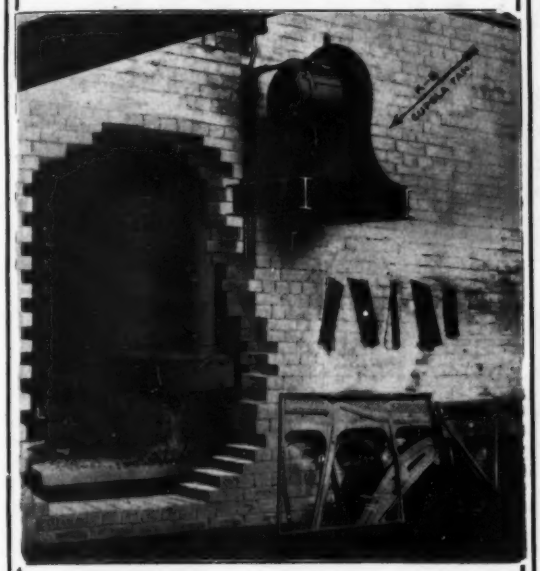


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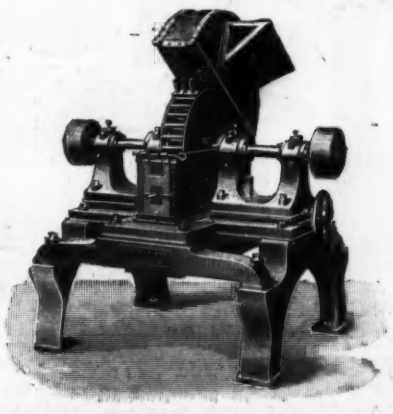

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